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Management of Environmental Protection Agency Project by Local Grantee

Final Report

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For

Municipal Construction Division (WH-547)
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The purpose of this report is to identify contemporary grantee Project Management techniques, critically analyze those techniques which are weak or ineffective, identify techniques which will improve grantee operations, and establish the basic costs for grantee Project Management services.

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This report resulted from the cumulative efforts of a large number of individuals and organizations. Many grantees, consultants, state and federal personnel contributed time, data from projects, ideas, and lessons learned through experience.

As we developed our tentative recommendations we received extraordinarily valuable guidance and input from an informal steering committee, consisting of Messrs. Harold Gold, Esq., Donald Barrie, Woodward Wilson, and Professors Robert Carr, John Melin and Boyd Paulson. These gentlemen shaped this study in its earliest, most critical stage by directing us away from impractical or unrealistic alternatives, and by their astute insights on good management practices.

The report was written by the Project Investigator, Associate Professor Weston T. Hester, Department of Civil Engineering, with the assistance of graduate students from the Department of Civil Engineering, School of Law, and School of Business Administration, University of California, Berkeley.

As a graduate student in the Schools of Law and Business Administration, respectively, Mr. Jim Graves, Esq., developed the questionnaire used for this study and also helped formulate the conclusions cited in this report. Ms. Laurie Peterson, a graduate student from the School of Law, researched many of the topics considered here. Mr. Hal Chapel, a specialist in data management and analysis, directed the gathering and analysis of the large amounts of data referred to herein.

Mr. Harold Cahill, former Director of the Environmental Protection Agency Construction Grants Program, encouraged and guided us in the study of grantee management practices.

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Finally, we owe a large measure of gratitude to the grantees and consultants who anonymously contributed to this study through their input of project data, ideas, and insights.

EXECUTIVE SUMMARY

For many local government agencies the planning, design, construction and operation of a wastewater treatment system represents the most difficult public works program ever attempted. Although some agencies have prior experience managing complex and costly projects, many others lack the sophistication needed to complete projects on time and within budget.

The purpose of this report is to identify contemporary grantee Project Management techniques, critically analyze those techniques which are weak or ineffective, identify techniques which will improve grantee operations, and establish the basic costs for grantee Project Management services.

The Construction Grants Program has undergone many changes since its inception, and the program will continue to evolve in response to the needs and available funding. But, every grantee, consultant and grantor agency representative we contacted believes there are specific reasons why the program is less effective than it could be. We believe the following are some of the most important:

1. Grantees receiving support from one or more state and federal agencies are frequently ill-prepared to coordinate the different parties involved and their overlapping or contradictory requirements;

2. Many consultants aggressively pursue the opportunity to plan, design and manage the construction of a project for a grantee, but at the same time explicitly disavow any responsibility to assist the grantee with cost or schedule control.

   Fearful of the liability associated with maintaining cost and schedule controls, some consultants use the NSPE Owner Designer Agreement [NSPE Document 1910-2] which states in part that:

   > [The designer] shall not be responsible for the means, methods techniques, sequences or procedures of construction selected by the contractor(s) ... he shall not be responsible for the failure of the Contractors to perform the work in accordance with the Contract Documents.

3. When grantees are negotiating for the provision of certain management-control services, including cost and schedule control, they frequently underrate their value, and may reduce or eliminate them in order to cut costs.

One of our highest priorities in this report was to help put these problems into a helpful perspective and to present specific, workable approaches to their resolution.

Regardless of the problems any one grantee is facing, and the source of these problems, there are at least three basic facts common to all grantees. First, the grantee bears full responsibility for the proper use of grant funds and effective functioning of the wastewater system. Secondly, EPA funding is limited and if changes in the project are to be grant-eligibile EPA must approve them as the project progresses. Finally, even relatively small projects involve complex financial and contractual arrangements between contractors, consultants, sources of finance and the grantee.

Based on our site-visits to grantees, responses we have received to a detailed questionnaire distributed to grantees, and input from consultant, EPA and state personnel, we have identified four "measures of grantee success" on a particular project:

ON A SUCCESSFUL PROJECT ...

1. The design work was completed less than 30 days late;

2. The construction phase was completed within the original schedule;

3. The actual cost of construction was less than 5% higher than the contractor's original bid amount; and

4. There were no construction contractor claims or when the claims were resolved the grantee received the bulk of the award.

Many supporters and critics of the EPA Program argue that larger grantees are more "successful" than the smaller grantees, and that EPA should take a more active role in assisting grantees with the management of grant funds. We agree that larger grantees are more likely to be successful, but do NOT believe that it is necessary for EPA to provide greater direct assistance to any grantee group.

We believe that a small number of proven management techniques can be used by grantees of any size to significantly improve their current operation and to LOWER their current costs. These techniques were deliberately selected to accomodate the de facto realities confronting the grantee and to reduce project delays, cost overruns and the likelihood of designer and contractor disputes. Summarizing:

A SUCCESSFUL GRANTEE ...

I. Carefully considers the qualifications and background of prospective designers.

I.1. Prior to selecting a project designer, consider each candidate's Errors and Ommissions insurance limits, record of delays and cost overrruns on previous projects, and any current claims or disputes with clients or others.

II. Closely monitors the schedule and projected costs of the work during design and construction.

II.2. Respond immediately to any problems which are revealed during the 50% design review;

II.3. Possess a detailed schedule for all planning and design activities;

II.4. Review the schedule for the project design monthly or more frequently;

II.5. Require progress reports on the project's design monthly or more frequently, AND reports on the estimated cost of the project on a regular basis;

II.6. Enforce the design schedule by notice to the designer, and threaten to or actually withhold payment if the work does fall behind schedule;

II.7. Possess a detailed schedule (e.g., bar chart, CPM, etc.) for all construction activities;

II.8. Conduct a review of the construction schedule monthly or more frequently;

II.9. Verify the progress of the work with respect to the schedule monthly or more frequently;

II.10. Update the construction schedule with each review; and

II.11. Enforce the construction schedule by notice to the contractor, threatening or actually witholding payments if the construction work falls behind schedule.

III. Resolves any difficulties which may arise during design and construction as soon as possible.

III.12. During construction, immediately resolve all change orders and disputes with the contractor

Relative to grantees using four or fewer of the recommended techniques, those using any nine to twelve of them experience:

1. a 145 day reduction in construction delays;

2. a 50% reduction in construction cost overruns;
3. an 85% reduction in successful construction contractor claims against the grantee; and

4. a LOWER total cost for administering the work.

Despite the fact these recommendations appear to be a classical prescription for good management, we find that relatively few grantees actually implement them. The most widely cited reason for not doing so is the apparent cost. Some grantees argue that close control of project costs and particularly schedules is expensive, frequently unnecessary and that professional consultants cannot or will not perform these services. Many grantees also argue that deferring resolution of some problems may permit more fact finding, reduce project costs and increase the likelihood of grant eligibility. We strongly disagree.

We have found that grantees that work with qualified staff or consultant personnel to actively develop and maintain cost and schedule controls, and to solve problems as soon as they arise, have LOWER construction costs, costs for force account and consultant services, and fewer claims than grantees that do not perform them. Although these techniques are costly, by using them the grantee's net costs are lowered through more efficient project administration, fewer construction contractor claims, and shorter construction times.

Relating these management techniques to the realities of limited EPA funding and the need to manage complex contractual arrangements, professional design and management consultants will need to assume greater responsibility for the preparation, receipt and evaluation of project cost estimates and schedules. And, all of the participants in the project, including the grantor and grantee, will need to develop a greater appreciation for the importance of timely decisions.

We emphasize the fact that additional assistance from EPA, the delegated State, or other grantor agencies will NOT necessarily enable the grantee to more successfully manage its projects. Rather, we recommend that small, medium and large size grantees consider using contract clauses which have been proven effective on previous projects, and adopt specific management techniques that will enable them to complete their projects in less time and for less money.

In conclusion, the grantee is fully responsible for the proper use of all funds, must seek concurrence of EPA on major decisions if grant-eligibility is to be assured, and needs to pay particular attention to the formulation and administration of its contracts with others. Fortunately, however, there are some relatively straightforward management techniques the grantee can use to effectively meet its needs. And, the implication of these techniques is that there will be more work for consultants and

better administered contracts for the contractor, but in turn these groups will also need to assume greater responsibility for cost and schedule control of their work and its effective administration.

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INTRODUCTION

The Environmental Protection Agency assigns complete responsibility for the planning, design, and construction of wastewater facilities to the local grantee. The management of these projects from plannning through construction, i.e., Project Management, is an immense challenge for even the largest and most sophisticated grantees. And, each grantee's relative success depends on a number of factors, from political support for the facility to the availability of qualified grantee and consultant personnel.

The purpose of this report is to identify contemporary grantee Project Management techniques, critically analyze those techniques which are weak or ineffective, identify techniques which will improve grantee operations, and establish the basic costs for grantee Project Management services.

To develop an accurate picture of grantee management practices we reviewed the available literature on grants programs and Project Management techniques, conducted a survey of representative grantees, and had numerous discussions with EPA consultant and grantee representatives. Perhaps surprisingly, despite their diversity, all of these sources yielded the same basic conclusions. Summarizing, some of the most cost-effective and efficient management techniques the grantee may exercise are selection of qualified consultants, development and maintenance of schedules for the design and construction work, and prompt resolution of problems and disputes.

Despite the fact that careful selection of consultants, close schedule control and a prompt response to problems appears like a classical prescription for good management, relatively few of the grantees we met actually perform these functions. In particular, few grantees actively monitor project schedules or work to resolve disputes as soon as they arise. The most widely cited reason for not doing so is the apparent cost. Grantees argue that close control of project schedules is costly, frequently unnecessary and that deferring resolution of some problems may permit more fact finding, reduce costs, and increase the likelihood of grant eligibility. We have reached the opposite conclusion.

We have found that grantees who work with qualified consultants to actively develop and maintain comprehensive schedules during design and construction, and who resolve disputes promptly, have LOWER construction costs, costs for force account and consultant services, and fewer claims than grantees who do not perform these services. Although these techniques are costly, by using them the grantee's net costs are lowered because of more efficient project administration, fewer construction contractor claims, and shorter construction schedules.

If the number of grantees involved in audit disputes, alleged mismanagement and construction contractor claims continues to

increase, we will probably witness a call from many public and private organizations for greater EPA management assistance to local grantees. No doubt, one argument which will become fashionable is that since EPA provided a large amount of the money originally spent by the grantee, EPA should share in the burden of managing the project and disputes resulting from the work. And, there will also be renewed calls for grantee use of "advanced" management techniques such as turnkey construction, construction management, etc.

In Chapter 2, Contemporary Approaches to Project Management, we show that any one of the approaches the grantee may use to manage his project has specific limitations, but also that public and private owners are increasingly recognizing that the overall approach used, e.g., construction management versus greater EPA involvement, is much less important than the management services performed by the grantee.

A topic of growing concern to grantor and grantee agencies is the legal obligation of the grantee's professional consultants to compensate the grantee for damages. For example, when higher costs, operations breakdowns and schedule delays occur on a particular project, an increasing number of grantees are turning to their professional consultants to share in the associated costs. In large part because there are few precedent setting cases where the consultant was held liable for mismanagement, there are few specific guidelines for evaluating the Project Management consultant's liability. But, referring to established legal principles and those cases we do have, in Chapter 3, Professional Liability, we show that consultants are increasingly and deliberately disclaiming responsibility for management functions. And, we also review those circumstances where liability can be assigned to consultants.

To identify the management techniques which "successful" grantees found most helpful, and those which were counterproductive, we met personally with the senior officials of over twenty grantee agencies and their consultants. We inquired about the overall grantee organizational structure, grantee policies for selecting and using consultants, particular management problems grantees were experiencing and the administrative costs normally incurred.

Supplementing the personal visits, we also surveyed a number of grantees to identify elements of their Project Management effort, and we analyzed the data collected. In Chapter 4, The Contemporary Grantee, we reviewed two composite pictures of the Construction Grants Program grantees based upon this data. First, a picture is developed of the grantees according to the population served and, second, with respect to the management techniques that they use.

As a "conclusion" to this report, we developed a series of specific recommendations which grantees may implement to improve the effectiveness of their grant management effort. In developing our recommendations we emphasize specific techniques

with established records of cost effectiveness, and which would not require changes in the EPA regulations. In conclusion, we believe that if grantees adopt the recommended management practices, the costs and time associated with their projects will be significantly decreased. Our recommendations are presented in Chapter 1, Recommendations.

CHAPTER 1

RECOMMENDATIONS

1. Measures of Grantee Success:

Two of our most important objectives in this work were to identify specific Project Management methods which would improve the efficiency of grant funded operations, i.e., make the grantee more "successful," and to establish the costs of both the contemporary and proposed management methods.

As we studied various management techniques and their associated results, we adopted four measures of a "successful" grant funded project:

1.1 The design work was completed less than 30 days late.

Timely completion of the design may permit the grantee to schedule construction bids for a time when lower bids are more likely, allow the grantee to estimate more accurately final costs and effective operations dates for the completed facility.

The design work was completed less than 30 days late on approximately three-fourths of the projects we investigated.

1.2 The construction phase was completed on schedule. Completion of construction early or "on schedule," i.e. within the time originally specified in the grantee-contractor contract, permits grantees to minimize consultant and force-account costs associated with the construction phase, and allows the grantee to meet its own commitments for system operation.

Approximately one-fourth of the projects we investigated were completed within the time originally agreed upon.

1.3 The actual cost of construction was less than 5% higher than the contractor's original bid.

Changes in the original construction contract to accomodate changes in the original work or other conditions are virtually inevitable during construction. The most common "changes" are grantee recognition of differing site conditions, but may include clarification of the contract documents, small additions to the work and approval of substitutes to items specified.

Most changes result in an increased cost of construction, and a 5% increase in total costs is considered typical. The actual cost of construction was less than 5% higher than the contractor's original bid for approximately three-fourths of the projects we investigated.

1.4 There were no construction contractor claims for a particular project, or claims that did occur resulted in the grantee receiving the bulk of the award.

Construction contractor claims, i.e., unresolved disputes between the grantee and construction contractor, are increasingly common and due not only to grantee actions but also to increasingly competitive bidding for projects, and a greater contractor "claims consciousness."

However, there is much that the grantee can do to minimize the likelihood of claims, their consequent costs (as in item 1.3 above) and to increase the probability of receiving the bulk of the award if the dispute does go to arbitration or litigation.

For approximately 80% of the projects investigated there were no claims or the grantee received the bulk of the award.

2. Recommended Management Techniques

Based on our meetings with numerous grantees, a review of the literature and data developed through a survey of grantees, we have established three basic management techniques which significantly increase a grantee's likelihood of "success'" as defined by the above 4 criteria: (1) carefully consider the qualifications and background of prospective project designers; (2) closely monitor the schedule of the work during design and construction; and (3) resolve any difficulties which may arise during design and construction as soon as possible.

2.1 Consider the prospective designer's previous experience.

In addition to evaluating a prospective designer's technical ability and experience with a particular type of project, we believe that the grantee should consider the limits on his Errors and Omissions (E/O) insurance, his prior record of delays and cost over-runs on similar projects, and any current claims or disputes that he may have with clients or contractors. We consider that a grantee used this technique

successfully if he considered any two of these criteria.

Although we recommend that grantees consider a prospective consultant's E/O limits, prior "track record" and relationships with others, we also recognize that this information is generally not released by consultants for fear of its being misconstrued or abused by competitors. We also recognize that the consultant's E/O insurance coverage, even though high, can be consumed by a small number of prior disputes which will then leave the grantee without compensation. But, these problems notwithstanding, if the grantee can assure the consultant that the data provided will remain confidential and will not be considered seriously, we believe most consultants will comply with the grantee's request.

The professional consultant's response to inquiries about his background in these areas is not necessarily indicative of what the grantee will experience with the same personnel on his project, but using this information the grantee may be able to make more informed selection between consultants. And, making an informed selection is particularly important since beyond his voluntary contribution it will be extremely difficult for the grantee to compel the project designer or construction manager to make a financial contribution towards correcting an improperly operating plant or resolving a construction contractor claim.

Contemporary procedures for holding the professional legally liable are rigorous, and pursuing the recover of cost through legal maneuvers is time consuming and costly. Therefore, it is to the grantee's advantage to select consultants with an established record of timely completion and workable relationships with all of the parties involved.

2.2 Schedules

There are at least four basic elements to the effective use of project schedules: (a) possession of a Master schedule depicting the major events, duration and inter-relationships for the duration of the work; (b) a periodic review and/or verification of the schedule whereby the actual progress of the work is compared with that projected; (c) the preparation of progress reports and/or an updated schedule through which the grantee, designer and/or contractor jointly agree on the work done to date and the projected effect on subsequent operations; and (d) the possession of appropriate enforcement mechanisms.

The possession and use of a meaningful schedule for the planning, design and construction phases is valuable for several reasons. First, the exercise of constructing a meaningful schedule for the work disciplines the persons preparing it to plan the work, and consider those items which may disrupt it. Secondly, once prepared and agreed upon by the grantee, the schedule can serve as an excellent basis for discussing and recording the effect of changes in the work, and disruptive influences on the overall schedule.

For the purposes of our Recommendations we have represented the schedule of the project's design and construction work by nine separate management techniques:

1. The grantee's possession of a detailed schedule of the work for the design phase;

2. Design schedule reviews monthly or more often;

3. Design progress reports monthly or more often;

4. Enforcement of the design schedule by notice to the designer, or threatened or actual withholding of payments if work falls behind schedule;

5. The grantee's possession of a detailed construction schedule;

6. Construction schedule reviews monthly or more often;

7. Verification of the schedule and work-in-progress monthly or more often;

8. Updating of the construction schedule with each review;

9. Enforcement of the construction schedule by notice to the contractor or the threatened or actual with-holding of payment if construction falls behind schedule.

There are numerous methods for representing project schedules, and any one or combination may be used. The critical value of this step is to be able to understand and respond to developments in each phase or part of the project, and schedules are particularly valuable for this purpose.

We emphasize that adoption of advance schedule techniques, such as CPM networks, is not in itself a guarantee of good project schedule controls, but rather the most important consideration to exercise when

selecting and specifying scheduling techniques is that the schedule as developed be accepted, understood and used by all the persons associated with the project. For example, design phase activities may be meaningfully represented by bar charts, comparisons of projected versus expended man-hours for particular tasks, or other simple measures. Similarly, many simple construction operations may be represented by Gantt bar charts, line-of-balance diagrams, etc.

2.3 Immediate resolution of problems.

Many of the problems which arise during the design or construction work are complex and require a cooperative effort between the grantee, consultants and contractor to reach an equitable solution. However, in part because these problems are so complex and a workable approach to them is not always apparent, many of the grantees with which we have met defer the resolution of problems until a more "convenient" time, usually at the end of the respective design or construction phase.

Unfortunately, however, in many cases this deferral may be accompanied by a loss of productivity, misplacement or destruction of the pertinent records, further deterioration of the grantee-consultant relationship, or other problems. In conclusion, then, we recommend that as a minimum the grantee identify and immediately resolve serious problems revealed at the routine 50% design review; work for immediate resolution of contract changes or disputes with the contractor.

3. Cost of Recommended Services

In our discussions with grantèes, consultants and EPA personnel, virtually all associated increased force account and consultant costs with the previously recommended management techniques.

In fact, the grantee using force account or outside consultants for the recommended techniques reported lower administration costs than grantees who did not. For example, working with our sample of grantees, those using up to four techniques spent approximately 5% of the construction cost on all administrative services, whereas those performing nine to twelve services spent approximately 4.4% of the construction cost on administrative services (more detailed summaries of these statistics are presented later in this report). Virtually all of the data we have compiled supports the conclusion that use of the recommended services costs no more than contemporary grantee management techniques, and will probably result in lower administrative costs, regardless of grantee or project size or type.

The fact that use of the recommend services may result in

lower administrative costs for the grantee is also intuitively clear. First, for example, the explicit purpose of the scheduling procedures recommended is to facilitate earlier completion of the work, with consequently lower administrative costs. And, in fact, grantees using these techniques do complete the work sooner with both lower administrative and contractor costs.

Second, careful consideration of the designer's previous experience and prompt resolution of all problems and disputes before the design progresses or is completed may minimize potential design-related problems, and facilitate maintenance of workable relationships.

Summarizing some of the discussion presented later in this report, the effect of using the recommended techniques on project costs and delays may be summarized as follows:

Number of Recommended Techniques Used	Total Administrative Costs as a Percentage of Construction Costs	Average Delay in Completion (days)	Average Cost of Construction Over Contractor's Original Bid
0-4	5.0%	243	5.4%
5-8	4.6%	197	4.3%
9-12	4.4%	97	2.7%

4. Conclusion

We have considered recommending greater EPA assistance to individual grantees, more (and less) grantee commitment of grant funds for management services, and numerous other techniques to enhance the ability of individual grantees to manage properly their projects. But, based on all of the information available to us the most effective management techniques the grantee can use are those outlined above, and are readily available through professional consultants for those grantees who do not already have the capability to provide them. And, futhermore, use of these recommended services is not expected to result in higher administrative cost, and requires little assistance from EPA or other agencies to implement.

Chapter 2

CONTEMPORARY APPROACHES TO PROJECT MANAGEMENT

1. Introduction

For many grantees the planning, design and construction of a wastewater system represents the most difficult work ever attempted. Although some have prior experience with complex and costly projects, many others lack the technical and managerial sophistication to complete the project on time and within budget.

If the number of grantees involved in audit disputes, alleged mismanagement and construction contractor claims continues to increase, we will probably witness a call from many public and private organizations for greater EPA management assistance to local grantees. One argument which may become fashionable is that since EPA provided a large amount of the money originally spent by the grantee, EPA should share in the burden of disputes resulting from the work. And, there will also be renewed calls for grantee use of "advanced" management techniques such as turnkey construction, construction management, etc.

As the authors of this report, we believe the number of grantees involved in disputes will increase rapidly in the next few years, but we also believe that additional EPA involvement in the grantee's own project management effort, or the adoption of a turnkey or construction management approach will not necessarily result in better managed projects with fewer disputes.

In this chapter, we explicitly show that any one of the overall approaches the grantee may use to manage its project has specific limitations, but also that public and private owners are increasingly recognizing that the overall approach used, e.g., construction management versus use of the original project designer, is much less important than the management services performed by the grantee.

Broadly, the technical services which must be performed to complete a wastewater facility include evaluation of alternate systems, facility planning and design, preparation of contract documents and monitoring of the construction work. Professional management services performed to direct and monitor the work include development of long-term cost and schedule goals, monitoring of the project-specific costs and schedules, and assistance with resolution of disputes. In conclusion, we encourage the grantee to emphasize performance of these services and not necessarily adopt any one of the standard management approaches.

A number of terms have been used to describe the management systems grantees use to plan, implement and control their work. Program Management (1) refers to the grantee's management of the entire wastewater system, Project Management (2) refers to the management of all work related to a specific facility, and Construction Management (3) to management of the construction phase operations on one or more projects. In this chapter we review the development of the principle management approaches used in Project Management and the respective advantages and limitations.

2.0 Alternate Approaches to Project Management

Until recently, many grantees implicitly assumed that with their use of a standard Owner-Professional Consultant contract agreement that the consultant would take charge of the project from beginning to end; that is, he would act as a Project Manager and perform all of the necessary technical and management functions. (4, 5) However, a large number of new priorities and requirements are reshaping this traditional Owner-Consultant relationship, and many grantees may need to revise their expectations.

Alternate approaches to Project Management began to develop during the Second World War when owners became increasingly concerned with achieving the lowest cost of construction in the shortest period of time. In the late 1940's and early 1950's, Turnkey contracts, where a single contractor provides design and construction services, was a popular approach. (6) In principle, with the turnkey contract approach the consultant provides all of the necessary planning, design and construction services necessary to provide a facility with the desired performance.

In the late 1960's and early 1970's, the use of a Construction Management firm in lieu of the original designer during construction became popular among owners in their attempt to reduce costs and construction time by more carefully controlling project schedules and cost. (7, 8) And, more recently, as owners and contractors have become disillusioned with the Construction Management approach, more effort has been placed on hiring specialized consultants to perform particular functions and to supplement the original project designers. (9)

2.1 The Traditional Approach

The classic approach to grant funded work is for the grantee to act as Program and Project Manager with substantial assistance from private, professional consultants. Typically the grantee will develop and maintain a master schedule and budget for completing the entire system, but contract with professional consultants for planning, design and certain construction services. Thus, the grantee retains nominal

control over the direction and progress of the work, but does not commit its personnel resources to a short term project.

Historically, the professional architectural and engineering societies representing consultants have encouraged owners to rely on private consultants and to use this "traditional" approach. For example, at one time the standard Owner-Architect agreements defined the Architect's duties quite broadly from preparation of preliminary studies to supervision of the work. (4) And, according to the commentary accompanying a National Society of Professional Engineers (NSPE) Owner-Project Manager agreement, the Project Manager "takes charge" of the project:

> " . . . the Project Manager . . . in effect, takes charge of the Project from beginning to end in order to provide special expertise and relieve the Owner of duties and responsibilities which the Owner is neither qualified to undertake nor for which he will have a continuing need." (5)

Proponents of this traditional approach argue that use of a single professional consulting firm representing the grantee from planning through construction simplifies the grantee's own management responsibilities and is cost-efficient. The grantee can establish and interact with a single contact throughout the project's life and thus need not take an active part in the Project Management. Also, if the original professional design consultant is involved during the construction phase, questions about the work may be resolved quickly and directly.

The advantages notwithstanding, use of this approach has been declining recently. Some consultants, fearful of assuming unwanted liability for activities beyond their control, are explicitly disavowing any responsibility for cost or schedules, and also limit their responsibility for inspection of the work. (10) And, in a related development, since few consultants have personnel familiar with advanced management techniques such as cost and schedule control, they are drawing a sharper distinction between the technical and management services provided and are excluding those they are not prepared to offer. The net result is that in order to satisfy their own management needs grantees are either expanding their own staff or contracting for specialized management services from other consultants. (11)

In conclusion, for many years the traditional arrangement between the grantee and consultant resulted in the consultant providing the full range of planning, design and construction oversight services necessary for Project Management. More recently, however, professional consultants have narrowed the range of services offered grantees and are explicitly excluding responsibility for project costs, schedule, project inspection and certain other functions. And, whereas in the

past grantees had given only limited attention to development and maintenance of detailed cost, schedule and inspection records, they are now developing these in detail in order to minimize audit related and construction contractor disputes.

2.2 Turnkey Project Management

During the Second World War and early post-war industrial development, owners explored a number of different techniques to speed planning, design and construction processes. Owners were concerned with controlling costs and efficient use of their own staff, but there was also an overriding emphasis on completion of the facility as soon as possible. The Turnkey approach, where the owner contracts with a single contractor to provide a complete facility ready for operation, was particularly popular during this period. (6) Variations and other names applied to it include "single-source, design-construct responsibility" and the "design-construct" approach. (12)

The fact that the contractor may overlap planning, design and construction operations and the responsibility for the facility performance can be clearly focused are widely cited as the principle advantages of this approach. It has been considered for wastewater facilities, and its advocates argue owners (i.e., grantees) will be able to save time, reduce escalating costs and focus responsibility for operational problems on one single firm. (12)

The apparent advantages notwithstanding, the complex dynamics of simultaneous design and construction may result in unexpected costs for the owner. Abnormal weather, site conditions, unexpected problems with regulatory agencies and other unforeseen events over the several year life of a typical project can make it extremely difficult to plan and forecast time and costs associated with the future work, and the consultant will want to be reimbursed for these unexpected problems. (7, 8)

For unsophisticated owners, or those expecting to use the Turnkey approach to minimize their responsibilities, the problems associated with the assumption of liability and guarantees of performance by the consultant may pose the most serious obstacles. In effect, the grantee may want an explicit guarantee the facility will meet established performance standards for water quality, cost of operation, etc., and for the consultant to assume responsibility for meeting these standards. In fact, however, consultants cannot afford the open-ended costs such unilateral guarantees impose, and insurance which may support performance warrantees is usually quite costly and limited in coverage. (6)

In summary, the Turnkey method is appealing because it focuses responsibility on a single contractor and the overall time

required to complete a facility may be shortened because design and construction can proceed simultaneously. But, in actual practice this method will be used even less frequently in the future due to the fact owners have not been able to adequately control and predict costs, and Turnkey consultants are sharply restricting their assumption of liability for the facility's performance.

2.3 Construction Management

The 1950's and early 1960's was an exciting period for owners, contractors and consultants associated with complex capital projects. The magnitude and number of industrial, commercial and defense related projects started after the Second World War continued to grow rapidly, the impact of private financing and inflated costs was considerably greater than it had been earlier, and new tools for control and management of these projects were being developed. (6) As owners placed even greater emphasis on timely completion of their projects, attention was also focused on scheduling tools and techniques. Project personnel tracked estimated and actual milestone dates and some developed elaborate Gantt "bar charts" for use in project control and planning.

But, the most important advances in project scheduling could be attributed to the development of the so-called Critical Path Method "CPM" network scheduling techniques by Hayward and Robinson at DuPont, and PERT for the Navy during the late 1950's. (13, 14) With the subsequent development and application of these networking techniques, project personnel were able to "track" thousands of separate activities and evaluate the impact of different events on the overall project schedule. During the 1960's, academic scholars and practitioners in the field further developed and refined the use of CPM, PERT and related techniques. And, a number of consulting organizations were formed to offer scheduling services, and computer-based "scheduling packages" were developed for use by several government agencies. (14)

As the scope and magnitude of industrial public works projects continued to expand, besides employing detailed project schedules, owners also attempted to minimize the problems associated with the use of the traditional, lump-sum construction contracts. Some public owners began "packaging" their construction contracts so as to start foundation construction, for example, while the balance of design was completed, and also adopted construction contract clauses which would minimize disputes and ease the burden of project administration during construction. (10)

Late in the 1960's, the federal General Services Administration (GSA) recognized the potential advantages associated with these advanced scheduling techniques and multiple bid packages, and promoted their use with greater

fanfare as "Construction Management." (15) Specifically, GSA defined Construction Management (CM) as:

> . . . a prime contractor (professional services) who will work with PBS (federal Public Building Service) and the architect to formulate the project budget, furnish the architect with information on construction technology and market conditions to insure their building design stays within budget, manage the procurement effort, supervise the construction of the building and provide, if desired, a wide range of other services . . . (15)

In summary, with the GSA approach the CM provides cost and schedule input to the project designer during the planning and design phases, assists the owner with development and award of multiple construction contracts to start construction while the final design is completed, and then assists the owner (e.g., GSA) with all management functions during the construction phase. (15) Unfortunately, GSA was not able to capitalize on CM as much as expected, apparently due to the CM's limited authority to enforce schedule and coordination requirements (7), and stopped using CM in 1980. (16)

However, as GSA's use of CM was declining, some grantees and delegated states became increasingly interested in a slightly different approach. In 1977, the state of California issued its Managing Construction of Claim Water Grant Projects (11) recommendations on the use of CM and actively encouraged grantees to employ a CM other than the original designer to administer the work, exercise cost and schedule control and perform other duties during the construction phase. In 1981, the state of Washington Department of Ecology issued its own guidelines. (17)

With the approach promoted by California, Washington and others, (8) the CM assists the grantee with development of an overall management plan, development and maintenance of a comprehensive cost and schedule control system, and administration of the work. (18) But, in contrast to GSA, the CM does not help award "phased" of fast-track construction contracts.

Although inconclusive, a small amount of data gathered by the state of California since issuance of its 1977 guidelines tentatively indicates that active use of a CM would result in shorter completion times, fewer change orders reduced increases in construction costs, but slightly higher administrative costs. Similar conclusions, but without supporting quantitative data, have been widely reported by others for conventional commercial and public construction projects. But, despite active encouragement, relatively few grantees have used CMs and most have apparently chosen to continue use of the original project designer in a limited

role during construction.

No doubt, there are many reasons why the concept of CM has not "caught on" despite its apparent advantages, but we believe that the principal obstacles are the lack of conclusive quantitative evidence that its use is cost-effective, an apparent shortage of persons capable of and willing to assume active responsibility for cost and schedule control activities, and uncertainty about the liability of the CM for its own and others actions. (6, 10, 19)

Most people (and even delegated state agencies disbursing funds), and particularly cash-short grantees, are not motivated to use a "new" service such as CM unless there are known cost-effective benefits. Interestingly, despite the widespread publicity and the use CM has enjoyed for over a decade, extraordinarily little quantitative data capable of winning the support of a skeptical agency Board of Directors or delegated-state contract review staff has been developed. In fact, all the grantees we have met and who are using CM services strongly assert that it is cost-effective, but also admit they lack objective data supporting their contentions.

Perhaps the most cost-effective CM service is active cost and schedule control. By using detailed schedule and cost projections when planning the work, and through maintenance of comprehensive records as it takes place, the grantee will be able to anticipate his financial needs and have a time-record to use in discussion with the contractor and designer. But, until relatively recently few consulting engineers (or contractors) were familiar with advanced scheduling techniques, including CPM networks, and thus placed little emphasis on their development and maintenance. This limited use notwithstanding, the number of persons using scheduling techniques is growing rapidly and the use of an appropriate scheduling technique by the contractor, professional consultant, or both, will probably become commonplace within the next few years. (14)

Advanced scheduling techniques are now included in contemporary undergraduate civil engineering curricula, contractors and consultants are finding them an invaluable tool for presenting and resolving construction contract claims, and many large civil engineering firms are developing specialists trained in cost and schedule administration as an essential element of their effort to manage large, multi-billion dollar projects.

Finally, the whole issue of professional liability has had a dramatic effect on the evolution of CM services. Since the mid 1960's, consulting engineers have become increasingly fearful of assuming responsibility for the construction contractor's work and associated liability. So, for example, many consultants actively monitoring the construction have carefully avoided responsibility for safety-related programs

and defects in the completed work (obvious sources of potential liability), but also for tracking the contractor's sequence and schedule of work activities. In effect, fearful of the assessment of unwanted liability some consultants offering construction monitoring or oversight services also explicitly exclude certain services which would be particularly valuable to the grantee. (20)

Because of the whole issue of CM liability it is still undergoing a rapid evolution; it is impossible to predict precisely what effect it will have on the CM services offered. However, at least for the next few years if a grantee wants certain allegedly "high-risk" services from a consultant, including schedule control, then these should be explicitly stated in the grantee-CM contract.

To summarize, the term Construction Manager or CM typically represents the professional consultant providing specialized services encompassing development of a management plan, active cost and scheduling control, assistance with the development of the contract documents and the negotiation of changes during construction. And, most of these services are performed during the construction phase. Although widely publicized and recognized as "valuable", few public owners are actively using CM, perhaps due to the uncertainty of benefits. But, as the benefits associated with good cost and schedule administration and other CM services become more widely recognized, successful grantees document the "true-cost" of these services and the people able to provide these services increase in number, we foresee that grantee use of CM or similar approaches will expand rapidly.

2.3 Special Consultants

Independently of any state or federal promotion of CM or related services, in the late 1970's and early 1980's, many grantees began to realize that strong cost and schedule control and vigorous contract administration could result in substantial benefits ranging from fewer contractor claims to lower administrative costs. In fact, most of the grantees we contacted began placing heavy emphasis on these services after battling complex construction contractor claims and seeking additional contract time from grantor agencies. In both of these situations the grantees found excellent project records and comprehensive cost and schedule projections were essential for defense of their position. (21)

Also, the net result of the recent grantee interest in advanced management techniques has not been the standard use of CM, per se, but another type of special consultant. Whereas with the CM approach as it was traditionally promoted the CM would perform all of the construction inspection, contract administration and scheduling functions and the project designer's role would be limited to submittal review and some interpretation of the contract documents, with the

"special consultant" approach the original project designer continues to assist the grantee with the development and award of construction contract packages, inspection of the work, submittal review and design interpretations; but, the usually separate, independent special consultant's role is limited to cost and schedule administration, negotiation of change orders and maintenance of project records.

With this approach the grantee retains the original designer as an active participant during the construction, but is also able to supplement the designer's special expertise and project familiarity with independent personnel specifically contracted to provide cost and schedule control, documentation services and change order administration. Advantages of this approach include the grantee's ability to employ a separate organization with particular strengths in facility design and management, respectively. Conflicts of interest which may occur if the original designer oversees implementation of his own design during the construction phase are minimized, and the special consultant is explicitly agreeing to provide particular services which designers have more recently explicitly excluded.

The principal disadvantages associated with the use of special consultants are that they will increase the grantee's own administrative effort due to the employment of additional consultant personnel and costs for consultant services. Also, unlike those providing traditional planning and design services, consultants providing management services such as cost and schedule control may not be able to obtain professional liability insurance. These potential disadvantages notwithstanding, we anticipate a rapidly expanding acceptance of this approach to Project Management.

In summary, grantees are increasingly using special consultants to fulfill their own limited need for specific services during the construction phase. With this approach the original designer continues to provide inspection, submittal review and other design related services during construction, but independently operating Special Consultants provide basic management services including cost and schedule control, contract administration and documentation.

3.0 Summary

Originally, grantees and owners of private projects assumed that their professional consultants performing planning and designing services would also provide all of the necessary management services to take charge of their project from planning through construction. In turn, professional consultants supported this assumption by suggesting standard form contracts using phrases implying a broad range of services, and the consultants offered many of the services these owners anticipated needing. But, as public and private owners became more concerned with shortening the time required

to go from planning through to facility start-up, a number of new approaches to Project Management were developed, including Turnkey and Construction Management (CM). Also, as professional consultants became increasingly concerned with the liability accompanying management services, some deliberately excluded these from their contracts with the grantees.

Shortly after the Second World War in a deliberate attempt to shorten the overall planning, design and construction process and to focus responsibility for plant performance, some owners used the Turnkey approach to Project Management. In effect, the single professional consultant assumed responsibility for the planning, design and construction of the facility to meet established performance standards. But, due to consultant imposed limits on the amount of liability they would assume and the fact that this approach allowed less owner-consultant control over project costs and schedules, this approach has been used much less frequently in recent years.

In the 1960's and early 1970's, CM and related services were widely promoted for public and private projects. CMs were employed to develop and award multiple contract packages for phased, fast-track construction and to maintain comprehensive cost and schedule records. But the CM concept, per se, was not as widely adopted as its promoters hoped, and today few grantees use the CM approach as it was originally defined.

In contemporary practice, a relatively new and promising approach to Project Management is for the grantee to continue to use the original designer for many of the design related functions during construction, but to employ an independent special consultant for specific management services, including cost and schedule control during the planning, design and construction phases.

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Chapter 3

Professional Liability

1. Introduction

Many grantees contract with professional consultants to provide the technical and management services needed to plan and design their projects, and monitor construction. In addition to the necessary technical services, the facility designer may also provide the basic Project Management services needed, or these may be procured from separate consultants. The "professional liability" of these consultants is in effect synonymous with their responsibility to the grantee or others for damages suffered due to their negligence or breach of contract.

According to common legal practice, to establish professional liability the grantee must show that the professional has a legal duty to the grantee; that by breach of contract or negligence he failed to meet an established standard for its performance; and that the grantee was harmed by, but was not the cause of the loss.

If, for example, an error is found in the original design of a machinery component, the grantee and designer typically negotiate the distribution of liability based upon the terms of the grantee-designer contract agreement. As a practical matter, some minor errors and omissions in the original design are considered inevitable, and designers frequently correct the design, if not the work itself, at their own expense. And, designers purchase errors and omissions insurance to protect themselves from the infrequent large losses attributable to design deficiencies.

Whereas the consultant's responsibility for facility design and performance may be clearly outlined in the contract documents, the same contracts are frequently vague about the consultant's responsibilities for management functions. And, since errors and omissions insurance is usually unavailable for management functions, many consultants hesitate to even appear responsible for them.

In this chapter the case-law precedents and contract provisions relating to liability of the professional consultant for management services are discussed in detail. In conclusion, it is shown that although the grantee and professional consultant may share an active relationship on a particular project, and

the grantee may rely heavily on the professional's performance of specific functions, most professionals incur relatively little liability for the performance of management services.

2.0 Establishing Liability

Based upon the literature study and survey compiled as part of this report, we have established that the grantee may pratically reduce cost overruns, delays and risks of litigation by exercising basic management services, including maintenance of schedule controls during the design phase; schedule control during construction; and immediate resolution of problems during design and construction.

In principle, to establish liability of the consultant for these management services the grantee must show that the consultant had a duty to perform them, that they were not performed according to the contract or were otherwise done negligently, and that consequently the grantee suffered losses. Unfortunately, in practice there is no industry consensus on the identity and level of management services a "reasonable" Project Manager would ordinarily perform, most grantee-consultant contracts exclude many of these and other services, and it is extremely difficult to isolate the specific harm attributable to the consultant's actions versus those of the grantee or contractor. And, consequently, there is extraordinarily little case law to provide guidance for those seeking to assess the liability of a consultant Project Manager. There are only two separate instances in which the CM has been held liable for his duties as caretaker of the project schedule and/or negotiator of project change orders.

In Green Plumbing and Heating Co., Inc. v. Turner Construction Co., 500 F. Supp 910 (E.D. Michigan 1980), the Mechanical Contractor (Green) contracted with the owner to construct a portion of a hospital, and Turner contracted with the owner to act as construction manager (CM). Subsequently, the mechanical subcontractor claimed the CM interfered with its contract with the owner, and that the CM was negligent in performing its scheduling and coordinating duties. The charge of the CM's negligence was later blocked, and the mechanical subcontractor was permitted to pursue the charge of tortius interference by the CM. Unfortunately, only a limited discussion accompanied this case and its outcome is not instructive.

The consolidated case of Edwin J. Dobson, Jr. Inc. v. Rutgers State Univ., 157 N.J. Super. 357, 384 A. 2d 1121 (1978), and subsequent Broadway Maintenance Corp. v. Rutgers University, 447 A. 2d 906 (S. Ct. N.J. 1982) contains a more elaborate, but direct statement on the CM's liability.

In this case the CM had agreed explicitly " . . . to enforce the combined schedule . . ." constructed by an outside CM

consultant and jointly approved by the other prime contractors on the job. Based on the CM's responsibility to enforce the schedule and coordinate the multiple contracts, the court held that it was responsible to the delayed contractors for their damages.

One lesson which we may draw from the Dobson case is that if the Construction or Project Manager explicitly agrees to utilize the project schedule to coordinate the contractor's work, then he may become liable for damages resulting from the delay.

3.0 Liability According to the Contract

The owner-consultant agreement is a logical starting point when evaluating the consultant's liability for management services. As in the Dobson case previously cited, the Project Manager can be held responsible for those services he explicitly agrees to perform.

Many professional societies and contractor associations have developed standard owner-consultant contract agreements, and although seldom used in their entirety, they contain many contract clauses which are widely adopted. Perhaps the most widely known standard form agreements are those issued by the American Institute of Architects (AIA) and the National Society of Professional Engineers (NSPE). For the purposes of this discussion we will focus on the following:

AIA Document B-141 (1977) ,	an owner-designer agreement;
AIA Document B-801 (1980) ,	an owner-construction manager agreement;
AIA Document A-201 (1976) ,	an owner-contractor agreement;
NSPE Document 1910-2 (1974) ,	an owner-designer agreement;
NSPE Document 2802 (1974) ,	an owner-designer and contractor agreement.

Each of these agreements contains some reference to the management services grantees need most, i.e., prompt resolution of change orders and close schedule coordination, but these references are seldom detailed. In the following discussion we compare the treatment of these different management services in the respective contract forms.

3.1 Immediate Resolution of Design Problems and Changes or Disputes During Construction

One of the key management services a Project Manager can provide is to help the grantee promptly review and resolve change orders and disputes. Prompt resolution reduces the uncertainty inherent in any unresolved matter, and enables the grantee and contractor to plan their work more effectively.

None of the standard form contracts explicitly require the consultant to seek immediate resolution of design problems,

changes or disputes during construction, perhaps due to the fact that many design or construction problems require substantial investigation before they can be resolved. Unusual delays or lack of diligence by the designer or construction manager, however, may be handled according to doctrines of professional liability.

3.2 Schedule Control During Design

In earlier sections of this report, it was established that design schedule control is improved by the use of the following four techniques:

1. the owner's possession of a detailed design schedule;
2. monthly or more frequent schedule reviews,
3. monthly or more frequent design progress reports, and
4. enforcement procedures permitting the owner to withhold payment if design work is behind schedule.

The above contracts, however, do not include provisions for effective use of these techniques.

AIA Document B-141, an owner-designer agreement, provides the owner a design schedule only if he requests one. The provision states that:

> The Architect shall perform Basic and Additional services as expeditiously as is consistent with professional skill and care and the orderly progress of the Work. Upon request of the Owner, the Architect shall submit for the Owner's approval, a schedule for the performance of the Architect's services which shall be adjusted as required as the Project proceeds, and shall include allowances for periods of time required for the Owner's review and approval of submissions and for approvals for authorities having jurisdiction over the Project. This schedule, when approved by the Owner, shall not, except for reasonable cause, be exceeded by the Architect. (AIA Document B-414 s 1.8)

Recalling the four elements recommended for design schedule control, this contract provides a schedule (if requested by the owner), but no monthly reviews, progress reports or enforcement procedures.

"SPE Document 1910-2, an owner-designer agreement, provides only a suggested date of completion:

> (the designer) would expect to start our services promptly after receipt of your acceptance of this proposal and to complete our services within _____ months. (letter agreement incorporated by reference in NSPE 1910-2)

This agreement specifies a suggested date of completion, but provides no interim schedule control. It requires none of the four elements recommended for effective design schedule control.

NSPE Document 2802, an owner-designer and contractor agreement, contains a scheduling provision to cover design and construction. Its scheduling provision appears to provide only the scheduled date of start and completion:

> The work to be performed under this contract shall be commenced as of the _____ day following the execution of this contract and shall be completed within such time schedule as shall be mutually agreed to by the Owner and Engineer-Contractor. (NSPE Document 2802, Article 4)

This design and construction scheduling provision provides no interim schedule control. The specification of start and completion dates is insufficient to permit adequate assessment of the progress of the work. Like NSPE Document 1910-2, this agreement provides none of the four elements needed for design schedule control.

AIA Document B-801, an owner-construction manager agreement, contains one provision that could be interpreted as requiring a design schedule. It states that the construction manager shall maintain a project schedule that integrates and coordinates the designer's services with construction schedules. Under this agreement, which contains specific construction scheduling provisions described in detail in later sections, the construction manager is to:

> Provide for the Architect's and Owner's review and acceptance, and periodically update, a Project Schedule that coordinates and integrates the Construction Manager's services, the Architect's services and the Owner's responsibilities with anticipated construction schedules. (AIA Document B-801 1.13)

The provision states that the schedule shall coordinate the parties' responsibilities with reference to "anticipated construction schedules" (emphasis added). This wording may imply that the construction manager is to schedule portions of design work that are concurrent with construction that is to begin shortly.

If this clause were to be applied to the design phase, it would provide a schedule for design services, apparently including specification of some design milestones. However, it provides no monthly review (although "periodic" updating is required), no monthly progress reports, and no schedule enforcement procedures.

3.3 Schedule Control During Construction

To control effectively the project schedule during construction, we believe that the grantee should:

1. possess a project construction schedule;
2. conduct monthly or more frequent schedule reviews;
3. verify the schedule and work in progress monthly or more often;
4. update the schedule with each review; and
5. have enforcement procedures permitting the withholding of payment if work falls behind schedule.

The current versions of the owner-designer agreements explicitly limit the designer's role in enforcing elements of the owner-contractor agreement. The designer denies responsibility for the construction contractor's failure to perform in accordance with the contract documents, which normally include the schedule agreed upon by the owner and contractor.

The owner-designer agreements provided by the AIA and NSPE have similar provisions limiting the designer's responsibility for the acts or omissions of the contractor. The AIA owner-designer agreement states:

> The Architect shall not have control or charge of, and shall not be responsible for construction means, methods, techniques, sequences, or procedures, . . . or the acts or submissions of the Contractor, subcontractors, or any other persons performing any of the Work, or for the failure of any of them to carry out the work in accordance with the contract documents. (AIA Document B-141, s 1.5.5)

Under the AIA agreement, the owner may contract for additional services during construction, which binds the designer to:

> . . . providing coordination of the work performed by separate contractors and the Owner's own forces. (AIA Document B-141, s 1.6.2)

The NSPE owner-designer agreement states:

> (the designer) shall not be responsible for the means, methods, techniques, sequences or procedures of

> construction selected by the Contractor(s) . . . He shall not be responsible for the failure of Contractors to perform the construction work in accordance with the Contract Documents.
> (NSPE Document 1910-2 s 1.6.2)

The NSPE design contract lacks an analagous provision for coordination of contractors and the owner, but does offer as an additional service:

> . . . services resulting from the involvement of more than one prime contractor for construction of the project. (NSPE Document 1910-2 s 2.1)

It is unclear what services are contemplated under this clause. The current versions of the owner-contractor agreements lack the elements necessary for adequate schedule control during construction. In the following section, we will inspect the construction scheduling provisions of AIA Document A-201. As we have seen in the earlier discussion of the NSPE owner-designer and contractor agreements, the NSPE agreement provides only the start and completion dates for the entire project.

The AIA owner-contractor agreement contains a scheduling clause which requires a schedule for the construction work:

> The Contractor, immediately after being awarded the Contract, shall prepare and submit for the Owner's and Architect's information an estimated progress schedule for the Work. The progress schedule shall be related to the entire project to the extent required by the Contract Documents, and shall provide for the expeditious and practical execution of the Work.
> (AIA Document A-210 s 4.10)

The terms of this contract provide for an "estimated" progress schedule, but little else. There is no requirement of schedule reviews, updates, or for the verification of the schedule and the work in progress. In addition, there is no schedule enforcement procedure available to the owner if the work falls behind schedule.

The construction scheduling provisions of the owner-construction manager agreements are more complete than those contained in the contracts we have already reviewed, but they do not specify all the elements necessary for effective schedule control.

The AIA owner-construction manager agreement contains construction scheduling provisions that provide a construction schedule, updating to reflect progress, and recommendations for enforcing the owner's contracts with other parties. The construction manager is to:

Provide for the Architect's and Owner's review and acceptance, and periodically update a Project Schedule that coordinates and integrates the Construction Manager's services, the Architect's services and the Owner's responsibilities with anticipated construction schedules.
(AIA Document B-801 s 1.1.3)

Develop a Project Construction Schedule providing for all major elements such as phasing of construction and times of commencement and completion required of each separate Contractor. Provide the Project Construction Schedule for each set of Bidding Documents.
(AIA Document B-801 s 1.1.5.3)

Consistent with the Project Construction Schedule issued with the Bidding Documents, and utilizing the Contractor's Construction Schedules provided by the separate Contractors, update the Project Construction Schedule incorporating the activities of Contractors on the Project, including the activity sequences and durations, allocation of labor and materials, processing of Shop Drawings, Product Data and Samples, and delivery of products requiring long lead time procurement. Include the Owner's occupancy requirements showing portions of the Project having occupancy priority. Update and reissue the Project Construction Schedule to show current conditions and revisions required by actual experience.
(AIA Document B-801 s 1.2.2.2)

Schedule and conduct pre-construction, construction and progress meetings to discuss such matters as procedures, progress, problems and scheduling. Prepare and promptly distribute minutes.
(AIA Document B-801 s 1.2.2.1)

Endeavor to achieve satisfactory performance from each of the Contractors. Recommend courses of action to the Owner when requirements of a Contract are not being fulfilled and the non-performing party will not take satisfactory corrective action.
(AIA Document B-801 s 1.2.2.3)

Under this construction management agreement, the owner is provided a schedule for construction, including the phasing of construction activities and the start and completion dates for separate contractor's work. The owner also is provided schedule reviews, although their frequency is not described. There is no verification of the schedule and the work in progress, but the contract does provide for scheduling updating "as required". Finally, the construction manager is to recommend courses of action to the owner when construction contracts are not being fulfilled. These recommendations would be forthcoming if the contractor was not performing

according to the schedule due to causes for which he is legally responsible.

In conclusion, the standard form contracts for design, construction and construction management do not provide the owner with the recommended procedures for schedule monitoring, maintenance and enforcement. The principal deficiencies of the contracts are lack of monthly schedule reviews and updates, inadequate schedule enforcement procedures, and lack of verification.

4. Conclusion

Grantees who employ Project Managers to provide management services are naturally concerned with their ability to hold the consultant liable for damages associated with his breach of contract or negligent performance of specific management services.

According to common legal practice, to establish professional liability the grantee must show that the professional had a legal duty to the grantee; that by breach of contract or negligence he failed to meet an established standard for its performance; and that the grantee was harmed, but was not also the cause of the loss.

We have shown that there is almost no case-law precedent for holding a Construction or Project Manager liable for negligence in the performance of particular management services. In one case where a detailed ruling was made, however, the CM was held liable for those services he had explicitly agreed to provide in his contract with the owner.

The fact notwithstanding that some consultants have been held liable for management services, we do not expect a large number of similar cases or decisions in the future. In a systematic review of contemporary, standard-owner consultant contracts forms we have shown here that most standard contracts are written in a way that minimizes the consultant's liability for particular management services. And, we note that these standard contract forms, and similar contract clauses, are widely used in contemporary practice.

Finally, we note that if the grantee wants to establish Project Manager responsibility for particular management services, and be able to hold the consultant liable for the consequences of negligence or non-performance, the grantee should explicitly specify the services to be provided in the grantee-consultant contract.

CHAPTER 4

THE CONTEMPORARY GRANTEE

1. Introduction

Federal and state agencies providing financial assistance to local grantees are naturally concerned that grant funds are managed properly and their original goals fulfilled. Although supporting statistical evidence is seldom cited, some observers of grant programs express concern that midsized and smaller grantees are sometimes mismanaging grant funds and receiving insufficient management assistance from the grantor agencies.

Previously, many agencies constructing capital-intensive grant funded projects were represented by experienced, if not large, sophisticated organizations with a detailed institutional knowledge of the workings and vagaries of design and construction processes. The state highway departments, for example, had developed large, comprehensive design and construction organizations. With the EPA grant program, a different type of grantee is becoming more common, and specifically we observe that few have personnel experienced with the design and construction processes, and many have difficulty meeting their established objectives.

To help us establish those management characteristics which "successful" grantees found most helpful, and those which were less helpful or were counterproductive, we met personally with the senior officials of over twenty grantee agencies and many additional consultants to discuss their experiences. We inquired about the overall grantee organizational structures, grantee policies for selecting and using consultants, particular management problems grantees were experiencing and the administrative costs normally incurred.

For grantees who were considered nominally successful by EPA, neighboring agencies or their peers, the management techniques cited as most important were the use of qualified personnel to perform and to oversee the work, and maintenance of close control over the design and construction work through detailed periodic reports and a prompt response to any problems which developed.

Conversely, virtually <u>all</u> of the grantees experiencing problems reported that the difficulties they had encountered could be attributed to insufficient preparation for the work, weak or nonexistent cost and schedule controls for design and construction, and the inability to act decisively on changes, questions about the design, etc. And, these conclusions and other observations made during these visits were corroborated by the results of our subsequent survey.

In this chapter we review two composite pictures of the Construction Grants Program grantees; first, a picture is developed of the grantees according to the populations served and, second with respect to the management techniques they used.

First, we categorized grantees according to populations served, i.e., large, mid-sized and small, and then developed a composite image of each grantee category based upon the data developed through our field visits and survey. In conclusion, we observed that smaller grantees are usually managed with substantial assistance from outside consultants and are frequently less successful in minimizing cost overruns and delays in project schedules. Conversely, larger grantees usually managed their work with outside consultants or by force account, and regardless of the personnel employed (consultant versus force account), these grantees are usually significantly more successful in minimizing overruns and delays.

Second, based on input provided by grantees and their consultants, published literature, and our survey, we have identified 12 management techniques grantees can use to reduce project delays, cost overruns and the likelihood of claims from designers or construction contractors. Summarizing, these techniques may be simplified to three basic concepts: 1) maintain close schedule control over the project throughout its life; 2) identify and respond to potential difficulties in a timely manner both during design and construction; and 3) carefully scrutinize the qualifications of all prospective professional consultants. In conclusion, the available evidence demonstrates that if these management techniques are used, the cost overruns, delays in project completion and construction contractor claims are minimized, and the grantees will actually expend fewer funds on force account and consulting services than those grantees who do not.

Many of our initial conclusions about what constitutes good and bad grantee Project Management practices were based upon discussions with EPA, grantee and consultant personnel. But, the consistency and responses from these persons notwithstanding, we believe that the most persuasive evidence supporting the merits of particular management practices is contained in the survey data. The survey data corroborated our observations from a large number of discussions, but most importantly provided specific, quantifiable measures of the value (or limitations) associated with particular management services. Because of its particular value we will emphasize the survey data in the attached discussion.

2. Grantee Characteristics: A Function of Population

2.1 Small grantees

For the purposes of this study, small grantees are defined as those serving populations less than 10,000 people. Approximately one-half of the grantees considered for this study are small.

Small grantees are typically cities, with approximately 1/4 constructing secondary facilities, while the others are constructing primary, tertiary, conveyance systems, sludge-handling systems, or pump systems.

Based both on our questionnaire and visits with numerous small grantees, we observed that they usually employ the original designers to manage the entire project from planning through construction, and that few hire a special consultant or manage their own projects.

The overwhelming majority of small grantees reported projects valued at less than $5,000,000.00 and had construction cost overruns due to change orders or claims of less than 5%, but a few had cost overruns greater than 10%

The total project duration ranged from less than two years to over six years; however, a majority of these projects had a duration of four-to-six years. Half of the grantees reported construction time overruns of less than six months; however, one-fourth had time overruns greater than six months.

The small grantee typically administered fewer than 25 change orders on the specified project, and spent less than 2% of the project costs on administrative force account work.

2.2 Mid-sized grantees

Mid-sized grantees are defined as those agencies which serve a population greater than 10,000 but less than 500,000. Nearly half of the grantees interviewed were mid-sized grantees, and are typically cities; however, some are county or special districts. The most common type of projects are up-grading of existing plants and conveyance systems, and these grantees were the least involved in the construction of tertiary plants.

About a third of the middle grantees managed their own projects, a third hired special consultants as construction managers, and the remaining third engaged the designer to do the construction management.

Half the middle grantees' projects were valued in excess of $5,000,000. A third of the grantees had construction overruns in excess of six months; however, the vast majority of middle grantees had cost overruns of less than 5% of project costs.

The middle grantee typically spent less than 2% of the project cost on administrative force accounts; however, the

percentage of project costs expended for administrative force account increased noticeably, on the average, as the grantee size increased.

As with small grantees, the mid-sized grantees reported administering fewer than 25 change orders for their specified projects.

Almost half of these grantees had project durations between four and six years, while nearly a third lasted over six years.

2.3 Large grantees

For the purposes of this study, large grantees are defined as those agencies serving a population greater than 500,000 people. Seventeen of the large grantees responded to our questionnaire.

The large grantees are typically a special district emphasizing the construction of an up-graded treatment facility or a new conveyance system. Fewer large grantees construct either secondary or sludge-handling systems.

The large grantees typically managed the construction themselves, while a few hired the designer to do the construction management work. A vast majority of these grantees managed a project valued in excess of $5 million. Of the 17 responding large grantees, three had projects valued in excess of $50 million.

A vast majority of large grantees reported construction cost overruns less than 5%, while no large grantees reported overruns in excess of 10% of the project costs. Half of these large grantees reported time overruns of less than six months, and a third reported overruns in excess of six months.

The large grantees typically reported a higher percentage costs expended on administrative force account than did small or middle grantees. Seven of the seventeen grantees spent over 6%, and the remaining were evenly divided between the two-to-six percent bracket and the less-than-2% bracket.

Half of the grantees processed fewer than 25 change orders, and most of those remaining administered between 25 and 50 change orders.

Large grantee projects typically lasted longer than small or middle grantee projects. These projects usually last in excess of six years.

2.4 Generalizations pertinent to all grantees

Comparatively, the larger the population served by the

grantee agency, the larger the dollar value of the projects and the percentage of administrative costs. Also, as the number of people served increases, the type of agency shifts from the city agency to county agencies to special district.

The grantee population also has an effect on the type of facility involved. Smaller grantees constructed more secondary systems and upgraded existing plants. As the grantee population increases, cost overruns decrease; however, time overruns lightly increase.

3.0 Twelve Specific Techniques for Effective Management

As we discussed alternate approaches to Project Management with different grantees and consultants, it became increasingly clear that no single approach to the project's organization or skillful use of consultants would result in a well managed project for all grantees. For example, some grantees were able to do extremely well with their own force account staff, while with others the use of their own staff was an apparent hindrance to effective Project Management.

Based on our discussions with participants in the Construction Grants Program, our review of the literature on Project Management and the results of our survey, we were able to identify a series of specific management services which grantees would find productive and efficient. We emphasize that these services, or any combination of them, can be utilized effectively for any size of grantee, project, or organizational structure. Thus, even grantees with well established programs may be able to readily adopt and implement them.

In the following section we present the specific Management techniques and document the relative costs and benefits associated with their implementation.

With respect to the planning and design phase of the work, the grantee should:

1) Consider the prospective designer's: a) Errors and Omissions insurance; b) record of delays and cost overruns on previous projects; and c) any current claims or dispute with clients or others.

   For the purposes of our work, we assume a grantee was using this technique if he considered any two of the above criteria;

2) Respond immediately to serious problems revealed during the 50% design review;

3) Possess a detailed schedule for all planning and design activities;

4) Review a schedule of the project design monthly or more frequently;

5) Require progress reports on the project design and planning monthly or more frequently; and

6) Enforce the design schedule by notice to the designer, and threaten or actually withhold payment if the work does fall behind schedule.

During the construction phase, a similar set of management techniques are used. In particular, the grantee should:

7) Immediately resolve all change orders or disputes with the contractor;

8) Possess a detailed schedule of all construction activities;

9) Conduct a review of the construction schedules monthly or more frequently;

10) Verify the progress of the work with respect to the schedule monthly or more frequently;

11) Update the construction schedule with each review; and

12) Enforce the construction schedule by notice to the contractor, threatening or actually withholding payment if the construction work falls behind schedule.

Through our investigations we have found that all grantees, regardless of population served or type of facility planned and constructed, can use these techniques to minimize unexpected cost increases and delays in the projects completion. Furthermore, we note that for grantees using these techniques the actual force account and administrative costs are equal to or lower than those for grantees not using them.

We have analyzed the data developed through our questionnaire and established specific conclusions with respect to these management techniques previously mentioned, and these conclusions are summarized in the following sections.

3.1 Overall Effectiveness of the Techniques

The tables presented in this section show the combined effect of the techniques. Some tables present data applicable to the design phase only, in which six techniques could be used. Others present overall project results, which combine the six techniques used during design with the six applicable to construction.

The tables below show the effect of techniques used during

the design phase. Use of the techniques was associated with a time saving of about 50 days, and a possible reduction in the likelihood of claims.

Table 1 Delay in Completing the Design Phase and the Number of Techniques Used

Number of Techniques Used (only 6 techniques apply to design work)	Average Delay in Completion of Design Work	Sample Size
02 techniques	70 days	92 grantees
34 "	50 "	73 "
56 "	17 "	51 "

Table 2: Number of Techniques Used During Design and the Likelihood of Claims in the Design Phase (only 6 techniques apply to design work)

Number of Techniques Used	%of Grantees Reporting Claims	Sample Size
0-2	8%	100 grantees
3-4	4%	74 "
5-6	6%	49 "

3.2 Overall Effectiveness of Techniques Used During Design and Construction

The three tables below show that use of the twelve management techniques was associated with:

a. a 145-day reduction in construction delays
b. a 50% reduction in construction cost overruns
c. an 85% reduction in successful construction claims against the grantee.

Table 3: Number of Techniques and Delays in Completing Construction (based on the originally scheduled completion date)

Number of Techniques Used	Average Delay in Completing Construction	Sample Size
0-4	243 days	26 grantees
5-8	197 "	120 "
9-12	97	92 "

Table 4: Number of Techniques Used and Construction Cost Overruns as a Percentage of the Original Contractor's Bid

Number of Techniques Used	Average Construction Cost Overrun	Sample Size
0-4	5.4%	25 grantees
5-8	4.3%	118 "
9-12	2.7%	93 "

Table 5: Number of Techniques Used and the Likelihood that the Grantee Will Lose a Claim from the Construction Phase

Number of Techniques Used	Likelihood that Grantee Will Lose Construction Claim	Sample Size
0-4	45%	22 grantees
5-8	20%	106 "
9-12	6%	90 "

3.3 Use of Techniques and Construction Administration Costs

The three tables below show that the direct costs of administering construction were not increased by the use of these techniques. In general, the total cost of administering construction, the cost outside construction management services, and the grantee's own force account services were lower when more of these techniques were used.

Table 6: Number of Techniques Used and the Total Cost of Administering Construction as a Percentage of the Cost of Construction

Number of Techniques Used	Administrative Costs As a Percentage of Construction Costs	Sample Size
0-4	5.0%	28 grantees
5-8	4.6%	109 "
9-12	4.4%	88 "

Table 7: Number of Techniques Used and the Total Cost of Administering Construction as a Percentage of the Cost of Construction

Number of Techniques	Construction Management Services as a Percentage of Construction Cost	Sample Size
0-4	5.8%	23 grantees
5-8	4.5%	93 "
9-12	4.8%	66 "

Table 8: Number of Techniques Used and Cost of Grantee Force Account Construction Management Services as a Percentage of the Cost of Construction

Number of Techniques Used	Force Account Costs as a Percentage of Construction Cost	Sample Size
0-4	1.6%	28 grantees
5-8	1.4%	110 "
9-12	1.3%	89 "

3.4 Use of Techniques and Construction Administration Costs, by Project Cost

The following tables show the number of techniques used and the total cost of administering construction. In general, the use of these techniques did not increase total administrative cost, regardless of project cost. The results for larger projects should be interpreted with caution due to the small sample size.

Table 9: Number of Techniques Used and Total Cost of Administering Construction as a Percentage of the Cost of Construction

1. Projects with Total Cost of Less than $5 Million

Number of Techniques	Administrative Cost	Sample Size
0-4	5.3%	20
5-8	4.6%	74
9-12	4.6%	52

2. Projects Costing from $5 Million to $15 Million

Number of Techniques	Administrative Cost	Sample Size
0-4	5.2%*	6
5-8	5.0%	18
9-12	5.3%	20

*These figures should be interpreted with caution due to the small sample size.

3. Projects Costing From $15 Million to $50 Million

Number of Techniques	Administrative Cost	Sample Size
0-4	1.5%*	1
5-8	5.7%	11
9-12	3.7%	11

4. Projects Costing $50 Million or More

Number of Techniques	Administrative Cost	Sample Size
0-4	1.5%*	1
5-8	3.9%	5
9-12	4.5%	4

3.5 Use of the Techniques and Cost of Outside Construction Management Services, by Project Cost

The following tables show the number of techniques used and the cost of outside firms used to manage construction. The tables have been broken down according to the cost of the project. In general, the increased use of these techniques did not require the grantee to pay more for outside construction management services, regardless of project cost. Some of the figures should be interpreted with caution due to the small sample size.

Table 10: Number of Techniques Used and Cost of Outside Firms Used to Manage Construction, as a Percentage of the Cost of Construction

1. For Projects Costing $5 Million or Less

Number of Techniques	Cost of Outside Construction Management Services	Sample Size
0-4	5.9%	15
5-8	4.8%	64
9-12	4.7%	45

2. For Projects Costing $5 Million to $15 Million

Number of Techniques	Cost of Outside Construction Management Services	Sample Size
0-4	6.0%*	7
5-8	3.5%	24
9-12	5.2%	16

3. For Projects Costing $15 Million to $50 Million

Number of Techniques	Cost of Outside Construction Management Services	Sample Size
0-4	3.0%*	1
5-8	4.5%*	5
9-12	4.9%*	5

*These figures should be interpreted with caution due to the small sample size.

3.6 Use of the Techniques and Cost of Outside Construction Management Services, by Grantee Population

The following tables show the number of techniques used and the cost of outside firms used to manage construction. The tables have been broken down according to the grantee

population. In general. the costs of outside construction management firms were lower when more of these techniques were used, regardless of grantee population. Some of the figures should be interpreted with caution due to the small sample size.

Table 11: Number of Techniques Used and Cost of Outside Firms Used to Manage Construction as a Percentage of the Cost of Construction

Grantee Population

1. Less than 10,000 People

Number of Techniques	Cost of Outside Construction Management Services	Sample Size
0-4	6.0%	12
5-8	4.5%	45
9-12	4.7%	33

2. 10,000 to 500,000 People

Number of Techniques	Cost of Outside Construction Management Services	Sample Size
0-4	6.1%	10
5-8	4.4%	47
9-12	5.2%	24

3. 500,000 People or More

Number of Techniques	Cost of Outside Construction Management Services	Sample Size
0-4	---	0
5-8	2.1%*	5
9-12	2.8%*	8

3.7 Use of Techniques and Total Construction Management Costs, by Grantee Population

The following tables show the number of techniques used and the total cost of administering the construction phase. The tables have been broken down according to the grantees' population. In general, the grantees with populations of less than 10,000 people reported lower total administrative costs when more techniques were used. Grantees with

* This figure should be interpreted with caution due to the small sample size.

populations of over 10,000 people reported slightly higher total administrative costs when more techniques were used.

Table 12: Number of Techniques Used and Total Cost of Administering Construction as a Percentage of the Cost of Construction

Grantee Population:

1. Less than 10,000 People

Number of Techniques	Total Administrative Costs	Sample Size
0-4	6.2%	15
5-8	4.7%	50
9-12	4.9%	38

2. 10,000 to 500,000 People

Number of Techniques	Total Administrative Costs	Sample Size
0-4	3.7%	15
5-8	4.7%	47
9-12	4.6%	28

3. 500,000 or More People

Number of Techniques	Total Administrative	Sample Size
0-4	---	0
5-8	3.0%*	6
9-12	4.5%	11

3.8 Use of the Techniques and Cost of Grantee Force Account Services for Construction Management, by Grantee Population

The following tables show the number of techniques used and the cost of grantee force account services during construction. The tables are broken down according to grantee population. In general, these tables show that grantee force account costs remain stable or decline with the use of additional techniques, regardless of grantee population. Some of these figures should be interpreted with caution due to the small sample size.

*This figure should be interpreted with caution due to the small sample size.

Table 13: Number of Techniques Used and Cost of Grantee Force Account Construction Management Service, as a Percentage of the Cost of Construction

Grantee Population:

1. Less than 10,000 People

Number of Techniques	Force Account Costs	Sample Size
0-4	.8%	13
5-8	1.1%	46
9-12	.9%	39

2. 10,000 to 500,000 People

Number of Techniques	Force Account Costs	Sample Size
0-4	2.7%	12
5-8	1.4%	49
9-12	1.6%	31

3. 500,000 or More People

Number of Techniques	Force Account Costs	Sample Size
0-4	---	0
5-8	1.9%*	6
9-12	1.8%	11

3.9 Use of Techniques and Cost of Grantee Force Account Services for Construction Management, by Project Cost

The following tables show the number of techniques used and the cost of grantee force account services during construction. "Force account" services refer to those provided by the grantees' own in-house personnel. These tables are broken down according to the costs of the project. In general, force account costs decreased when additional techniques were used. Some of these figures should be interpreted with caution due to the small sample size.

*This figure should be interpreted with caution due to the small sample size.

Table 14: Number of Techniques Used and Cost of Grantee Force Account Construction Management Services, as a Percentage of the Cost of Construction

By Cost of Project:

1. Less than $5 Million

Number of Techniques	Force Account Costs	Sample Size
0-4	1.7%	18
5-8	1.4%	69
9-12	1.1%	55

2. $5 Million to $15 Million

Number of Techniques	Force Account Costs	Sample Size
0-4	2.0%*	7
5-8	1.0%	22
9-12	1.6%	20

3. $15 Million to $50 Million

Number of Techniques	Force Account Costs	Sample Size
0-4	.5%*	1
5-8	1.6%	11
9-12	1.3%	10

4. $50 Million or More

Number of Techniques	Force Account Costs	Sample Size
0-4	.5%*	1
5-8	1.6%*	5
9-12	2.9%*	4

3.10 Analysis of the Specific Tactics

The individual effects of some of the techniques are shown below. Many of the techniques required the concurrent use of another technique (i.e., a schedule review cannot be conducted if no schedule is used), thus there are fewer individual analyses than techniques.

3.11 Qualifications of Design Consultants

The capabilities of the design consultant have a direct effect on the grantee's costs and schedule for at least two reasons. First, a lesser-qualified designer may require a

*This figure should be interpreted with caution due to the small sample size.

longer time and higher costs to complete the design work satisfactorily. Second, construction costs and time may be increased by construction contractor difficulty with incomplete or erroneous contract documents, inadequate contract administration, or an ineffective grantee/designer relationship.

The survey data indicate that the grantee should consider the previous record of prospective designers, including:

a. cost or time overruns on previous projects
b. errors and omissions insurance availability
c. pending litigation or other disputes with other owners who have hired the designer.

Table 15: Number of Prequalification Criteria Used and Cost Overruns as a Percentage of the Contractor's Original Bid

Number of Criteria Considered	Average Cost Overrun
0-1	4.0%
2	3.3%
3	2.5%

3.12 Development and Enforcement of a Master Schedule for the Design Phase

The development of a master schedule for the design phase allows the designer to plan more effectively his activities. In addition, the formal development of the schedule may alert the designer and other parties to potential difficulties.

As the design work progresses, the designer and grantee can use the schedule to remind them of activities scheduled for the near future. If work is progressing slower than anticipated, the owner will be in a much better position to alter his own time-table to reflect the probable completion date.

The survey data did not reveal that the use of a design schedule had any effect on the completion of the design phase. However, grantees that did not have a design schedule or did not enforce it incurred an average delay during construction of 80 days longer than grantees that had a design schedule and enforced it. Enforcement consisted of notifying the designer that work was behind schedule, and if necessary, threatening to withhold payment or actually withholding payment.

3.13 Review of the Design Schedule on a Monthly or More Frequent Basis

Schedule review allows the grantee and designer to assess the progress of the design work, and to take timely action

to correct or minimize delays. The schedule review is an important aspect of effective management because delays and unexpected difficulties are frequently encountered on construction projects. If they are not noted by the grantee, their effects may be costly.

Grantees that reviewed schedules and work in progress during the design phase monthly or more often reported that design work was at least 6 months late on 9% of the projects. Grantees that did not use this technique reported that the design work was at least 6 months late on 20% of the projects.

Table 16: Frequency of Design Schedule Review and Delay in Completing Design Work

Frequency of Design Schedule Review	Percent of Grantees Reporting at least 6 months Delay
Monthly or more often	9%
Quarterly or not at all	20%

3.14 Identification and Correction of Serious Problems at the 50% Design Review

The 50% design review is an analysis of progress at the midpoint of the design phase. During this review, the grantee and designer consider the implications of the design as it takes shape. This review may consider the operations and maintenance costs, the availability of equipment or materials specified, and the results of geotechnical investigations of the proposed site. Although few grantees reported that serious problems were revealed by the 50% review, but not subsequently corrected, 11% reported that problems were not revealed by the review, but later became apparent.

Table 17: Outcome of 50% Design Review and Construction Cost Overruns as Percentage of Construction Cost

Outcome of 50% Design Review	Average Cost Overrun
No serious problems were revealed, or if revealed were corrected immediately	3.9%
Serious problems were not revealed, or if revealed were not corrected	4.1%

3.15 Development and Enforcement of a Master Schedule for the Construction Phase

The use of a master schedule in construction allows the grantee, designer, and contractor to communicate and to

plan their respective activities. In contrast to the design phase, in which the grantee and the designer may be the only active parties, construction adds the contractor and subcontractors. Delays are costly due to the amount of equipment and labor at the site, which must be paid for whether working or not, and the grantees' indirect costs due to inability to use the structure.

Construction delays are a fertile source of disputes and claims. The use of a construction schedule can reduce delay by coordinating the work of the parties and, if claims are filed, may be used as evidence to support or defend against them.

The construction schedule should include the timing and duration of major work activities. It should also describe the procurement and delivery dates of long lead time items, and the inspection dates of major equipment and systems. If there are subcontractors, it should show the interfaces between their work and the work of the prime or other contractors.

Grantees that reported that they used and enforced a master schedule during construction completed projects an average of 79 days earlier than those that did not. The enforcement procedures consisted of giving notice to the contractor that work was behind schedule, or the threatened or actual withholding of payment.

Table 18: Use and Enforcement of a Master Construction Schedule and Delay in Completing Construction

Grantee's Use of Construction Schedule	Average Delay in Completion
Did not use and enforce schedule	219 days
Used and enforced schedule	140 days

3.16 Review of the Construction Schedule on a Monthly or More Frequent Basis

Once specified, the construction schedule must be properly utilized. Frequent reviews of the progress of the work alerts the parties to current problems and activities planned in the near future. The schedule review should document the current progress of the work, corrective action to correct delayed activities, and preparation for upcoming work. The survey data indicate that schedule reviews must be conducted at least monthly to be effective in reducing delays.

Table 19: Frequency of Construction Schedule Reviews and Delays in Completing Construction

Frequency of Schedule Review	Average Delay
Monthly or more often	90 days
Quarterly or not at all	102 days

Table 20: Frequency of Construction Schedule Reviews and Percentage of Projects Completed on Time

Frequency of Construction Schedule Review	Percentage of Projects on Time
Monthly or more often	26%
Quarterly or not at all	20%

3.17 Updating of the Construction Schedule to Reflect the Current Progress of the Work

Effective project planning and the equitable, efficient resolution of delay claims requires the documentation provided by a schedule actually used on the project. Neither planning nor defense against claims can be done effectively with a schedule prepared after the fact. The construction schedule must be updated to show the effect of delays, accelerations and changes in the work whenever they occur. If the schedule is not maintained, it soon becomes useless as a planning tool and an inaccurate representation of the actual work logic.

Grantees that updated the schedule to reflect verified work in progress incurred cost overruns on construction averaging 3.7% of the original bid. Grantees that did not use this technique reported overruns averaging 4.1%

Table 21: Updating of Construction Schedule Versus Cost Overruns as a Percentage of the Cost of Construction

Construction Schedule Updating to Reflect Work	Average Cost Overrun
Schedule updated	3.7%
Schedule not updated	4.1%

The amount by which the cost of construction exceeded the contractor's original bid was strongly correlated with the extent of delay in finishing the project. On an average, grantees incurred an additional 1% rise in construction costs per 150 days' delay.

3.18 Resolution of Contract Changes or Disputes With The Contractor As Soon As They Occur

Most significant construction projects require minor changes in the work originally planned. These may be the result of slight design changes, the grantee's request to add or delete features, or ambiguous or incorrect design documents. Changes may also be required if the site conditions differ materially from those represented in the construction contract, or if unusually bad weather or other occurrence delays the work. These changes in the scope, time, or cost of the work are formally recognized by change orders which amend the original construction contract. Changes are a significant cause of cost overruns, delay, and claims.

Successful resolution of changes or disputes requires the agreement of the grantee and contractor on the scope, cost and time extension (if any) for the change.

Grantees that resolved change orders or disputes with the contractor immediately reported contractor claims on 8% of the projects. Grantees that deferred their resolution until the end of the project, or resolved them periodically reported contractor claims on 48% of the projects.

In addition, immediate resolution of changes or disputes with the contractor was associated with lower change order costs. Grantees that resolved them immediately had change order costs averaging 2.6% of the cost of construction. Owners that deferred resolution incurred change order costs averaging 4.1% of the cost of construction.

The survey data indicate that prompt resolution of changes or disputes with the contractor reduced the likelihood of claims and the extent of cost overruns resulting from construction.

4. Conclusion

We have considered recommending greater EPA assistance to individual grantees, more (and less) grantee commitment of grant funds for management services, and numerous other techniques to enhance the ability of the individual grantees to manage properly their projects. But, based on all of the information available to us the most effective management techniques the grantee can use are those outlined above, and are readily available through professional consultants for those grantees who do not already have the capability to provide them. And,

furthermore, use of these recommended services is not expected to result in higher administrative cost, and requires little assistance from EPA or other agencies to implement.

APPENDIX

1. Development of Questionnaire

One of the most effective means of establishing major patterns and trends in grantee management practices is to survey a randomly selected sample of contemporary grantees. Surveys conducted with written questions can be directed to a much larger sample of grantees than it would be feasible to visit personally, and the data gathered can be analyzed statistically to isolate particular developments.

Working with a number of grantees, consultants and California and federal EPA officials between December 1980 and April 1981, we developed and trial tested a 105 question questionnaire. Representatives from the University of California Survey Research Center provided some technical guidance to us in the development of the questionnaire format and the questions themselves.

In developing the questionnaire, we focused on seven topical areas, including:

a. objective project results, including the number and types of claims encountered during design and construction, and increased construction costs;

b. characteristics of the grantee agency (e.g., special districts, county, city, etc.,);

c. characteristics of the specified project, including costs and type;

d. description of the role of other agencies involved in the project, including the federal EPA, delegated state authorities and the Army Corps of Engineers on behalf of the federal EPA;

e. the roles of the project designers, construction managers and other consultants during design and construction;

f. management techniques utilized by the grantee, including considerations used when selecting consultants, project managers, the cost of the administrative techniques used, scheduling practices and change-order management; and

g. costs associated with the cost of the project.

Prior to adoption of the final questionnaire and format, rough drafts were submitted to grantees, consultants and representative EPA officials.

2. Question Format

To facilitate development of meaningful responses from the

grantees, we developed three basic types of questions: (1) multiple choice; (2) a format permitting the grantee to check all options which apply; and (3) a fill-in-the-blank format.

Multiple choice questions were used where all appropriate responses were mutually exclusive. Where multiple responses to the same question may have been appropriate, and no answer precluded any other response, the grantee was encouraged to check each answer that applied. Finally, to provide the grantee with adequate flexibility in responding, in a limited number of cases the grantee was asked to specify particular costs or percentages associated with his work.

3. Sampling Techniques

EPA provided us with a computer-tape listing of approximately 17,000 active grants in the construction phase (Step 3) in the United States and its territorial possessions. For the purposes of our survey, we limited our sample to approximately 1,000 grantees who had been shown at least 80% complete with the construction phase (Step). No grantee received more than one questionnaire, although some grantees had multiple grants.

Each grantee was asked to respond to the questionnaire with respect to a specific grant project. In the cover letter accompanying the questionnaire, the grantee was asked to respond to the questionnaire using the best of the available information, and assured that all responses would be kept confidential.

254 out of the 971 grantees actually contacted responded by completing and returning the questionnaire in an enclosed, self-addressed, stamped envelope addressed to the principal investigator at the University of California. Approximately 20 surveys were returned incomplete or were otherwise unusable.

Questions about the project as a whole (and about Step 1)

1. A. Please indicate below the total estimated cost of all Step 1, 2 and 3 work -- including any costs that are grant eligible.

Less than $5,000,000	65.2%
$5,000,000 - $14,999,999	21.6
$15,000,000 - $49,999,999	9.2
$50,000,000 or more	4.0

B. What is the estimated cost of construction, i.e., contractor bid price plus anticipated contingencies?

$_____ *

2. Which of the following best describes the grantee agency?

City	68.3%
County or unincorporated area	9.6
Sanitation district	21.3

3. What is the approximate population served by this grantee? If grantee was a county or unincorporated area, your answer should be for the total population of the county.

Less than 5,000 people	36.1%
5,000 - 9,999	13.7
10,000 - 24,999	27.0
100,000 - 499,999	14.6
500,000 or more	7.3

4. Who conducted the Plan of Study required by the EPA?

The grantee	7.4%
An engineer hired by the grantee	92.1

5. How many firms or persons submitted proposals that were seriously considered before someone (either the grantee or someone else) was selected to do the facility plan?

One firm or person	59.5%
2 firms or persons	8.0
3 firms or persons	14.3
4 or more firms or persons	16.9

6. How many proposals were considered for the Step 2 negotiations?

1 to 3	91.5 %
4 to 6	7.2
7 to 10	---
More than 10	.4

Questions 7 and 8 assume that there may be several Step 3 grants, including the specified one, originating from previous Step 1 and 2 grants.

7. Please estimate the respective grant amounts and actual costs for the specified project.

	Grant Amount	Actual cost to grantee	
Construction contract	$_____	$_____	*
Administration	$_____	$_____	*
A & E	$_____	$_____	*
Inspection	$_____	$_____	*
Contingency	$_____	$_____	*
All "force account" (i.e., provided by the grantee) work included in the above	$_____	$_____	*

8. As a percentage of the construction cost (contractor bid price plus contingencies), please estimate the costs for Step 1 and 2 assignable to the specified project.

Step 1:_____% *
Step 2:_____% *

9. As a percentage of the construction cost, please estimate the cost of administering the Step 3 phase. Please include inspection costs, schedule maintenance, grant administration and cost accounting, but <u>exclude</u> engineering design or technical review services.

Less than 3% of construction cost 33.6%
3 to 5.9% 31.0
6 to 8.9% 21.7
9 % of construction cost or more 12.8

10. Which of the following issues were discussed at the pre-grant conference(s) with EPA or any other funding agency? (Please check all that apply.)

Scheduling and timetables for work in progress 40.9%
Timetables for required EPA or other agency reviews and approvals. 40.2
There was no pre-grant conference. 44.9

Below are some issues on which EPA, the delegated state, or the Army Corps of Engineers may or may not have provided guidance.
For each issue, please check one box depending upon how much guidance was needed and how much was received. These questions pertain to Step 1,2 and 3 work.

11. How would you rate EPA (or other agency, such as delegated state or Army Corps of Engineers) guidance when planning the schedule dates for major design and construction activities?

No guidance was received and none was needed	34.3%
No guidance was received, but some was needed	10.7
Some guidance was received, but more was needed	18.2
Some guidance was received and that was sufficient.	35.5

12. How would you rate EPA (or other) guidance on developing contract packages (i.e., the scope"of work" for each contract) based on the type of work to be performed, the dollar magnitude of the contract package, or the number of contract packages to be awarded at or near the same time?

No guidance was received and none was needed	42.3%
No guidance was received, but some was needed	12.6
Some guidance was received, but more was needed	15.0
Some guidance was received and that was sufficient	29.3

13. How would you rate EPA (or other) guidance on cost accounting systems and project control systems?

No guidance was received and none was needed	28.3%
No guidance was received, but some was needed.	23.5
Some guidance was received, but more was needed	22.7
Some guidance was received and that was sufficient	25.5

14. How would you rate EPA (or other) guidance on the type of facility -- the appropriateness of the system design, its capacity, and the operation and maintenance costs?

No guidance was received and none was needed	33.3%
No guidance was received but some was needed	14.3
Some guidance was received, but more was needed.	15.0
Some guidance was received and that was sufficient	37.4

15. How would you rate EPA (or other) guidance on methods to minimize disputes with contractors?

No guidance was received, and none was needed	46.3%
No guidance was received, but some was needed	26.6
Some guidance was received, but more was needed	9.8
Some guidance was received and that was sufficient.	16.4

16. Which grantor agency was the grantee's principal contact during each step of the project? Please check one box for each Step.

	Step 1	Step 2	Step 3
EPA	37.6%	35.8%	29.7%
The delegated state	62.0	63.3	52.7
Army Corps of Engineers	--	.9	16.7

17. What type of facility was recommended by the Plan of Study? (please check all that apply.)

Upgrading or expansion of an existing facility.	.39.4%
Secondary wastewater treatment	.39.4
Tertiary wastewater treatment	.19.7
Conveyance systems	.42.1
Sludge handling	.25.2
Pump systems	.31.5

18. How long was the grantee in Step 1?

Less than 6 months	9.3%
At least 6 months, less than a year	.18.9
At least a year, less than 2 years	.30.8
At least 2 years	.39.2

In Questions 19-21, please estimate any costs of delay (not additional requirements) caused by funding agencies (other than the grantee). Please indicate the cost of any delay as a percentage of the cost of that Step.

19. Cost of Step 1 delays:

There were no delays due to funding agencies	.32.6%
There were delays, but they cost less than 1% of Step 1	.19.9
1% to 9.9% of Step 1 costs	.16.3
10% to 24.9%	.17.2
25% to 49.9%	6.3
50% or more	5.9

20. Cost of Step 2 delays:

There were no delays due to funding agencies	34.2%
There were delays, but they cost less than 1% of the cost of Step 2	18.7
1% to 9.9% of Step 2 costs	20.9
10% to 24.9%	18.7
25% to 49.9%	3.6
50% or more	4.0

21. Cost of Step 3 delays:

There were no delays due to funding agencies	41.7%
There were delays, but they cost less than 1% of the cost of Step 3	17.0
1% to 9.9% of Step 3 costs	21.7
10% to 24.9%	11.7
25% to 49.9%	4.3
50% or more	3.5

22. How many grantee personnel were assigned at more than half-time (20 hours per week) for management and administration of the project in Step 1?

0 to 3	95.7%
4 to 7	3.9%
8 to 12	---
13 to 24	---
25 to 49	---
50 or more	---

23. How many grantee personnel were assigned at more than half-time for management and administration in Step 2?

0 to 3	94.8%
4 to 7	4.3
8 to ---	.4

24. How many grantee personnel were assigned at more than half-time for management and administration in Step 3?

0 to 3	85.5%
4 to 7	12.0
8 to 12	.4
13 to 24	.4
25 to 49	.8
50 or more	---

25. Did a change in the grantee's personnel or policies during Step 1 cause any problems with the project?

There was no change in the grantee's personnel or policies	76.7%
There was a change in the grantee's personnel or policies, but it caused no problems with Step 1	14.7
There was a change in the grantee's personnel or policies, and it did cause problems with Step 1	8.2

26. Did the Step 1 proposals suggest any innovative or alternative technology?

Yes	25.6%
No	73.9

Questions About Step 2

27. How long was the interim period between the funding agencies' acceptance of the Facilities Plan and the grantee's filing of grant application for Step 2?

No interim period; Step 2 grant application was filed before Step 1 was completed	43.8%
Less than 30 days	15.4
30 to 89 days	11.1
90 to 179 days	8.2
At least 6 months, less than a year	7.7
At least 1 year	13.0

28. Who supervised the project designer in Step 2? (Please check all boxes that apply.)

Local government officials directly	63.8%
Another consultant	3.5
The project designer himself	56.7
Another government agency	15.7

29. Who reviewed the project designer's progress? (Please check all boxes that apply.)

Local government officials directly	76.4%
Engineer or designer himself	53.9
Another government agency	21.3

30. Who reviewed or approved the design (either interim or final) before submittal to a regulatory agency?

Local government officials directly	78.3%
Another consultant	3.5
Engineer or designer himself	53.9
Another government agency	19.7

31. Who (other than funding agencies) reviewed the design for operability and maintenance expenses and techniques? (Please check all that apply.)

Local government officials directly	67.7%
Another consultant	4.7
Engineer or designer himself	59.4
Another government agency	21.3

32. Which of the following issues did the grantee initiate and seriously consider during final review of the Step 2 design proposal? (Please check all that apply.)

Use of innovative or alternative technology	18.5%
Long-term maintenance costs	58.3
Long-term operation and personnel costs for the finished project.	64.6
Ability of the grantee to operate the facility with available personnel.	63.0

33. What type of cash flow problems did the grantee experience during Step 2? (Please check all that apply.)

There were no cash flow problems during Step 2	53.1%
Difficulty in getting EPA approval of amendments to the Step 2 design contract caused shortages	9.1
EPA delays in releasing funds to the grantee caused shortages	24.0
Other problems caused shortages (Please specify.)	4.7
Cash flow problems were anticipated and action taken in time to avert them	16.1

34. Was the same or a different engineer or designer used on Step 1 and Step 2?

Different designers were used on Steps 1 and 2	9.7%
The Step 1 designer did part but not all of the Step 2 design	3.4
Step 1 designer did all of the Step 2 design	85.7

35. Which, if any, of the following prequalification criteria were considered in selecting a project designer (in addition to the required (40 CFR 35-937.3) prequalification procedures)? (Please check all that apply.)

Cost or time overruns on previous projects	21.3%
Errors and omissions insurance availability	11.0
Pending litigation or other contract disputes with other grantees or owners	10.2
None of the above criteria was considered	67.7

36. How did the person or organization verify the project designer's progress in Step 2?

Verification of the project designer's work was done at Step 2 closeout only	13.5%
The project designer certified the progress	47.6
Inspection of the project designer's documents	38.4

37. During Step 2, how often did the project designer submit progress reports?

Every week	6.5%
Every other week	3.9
Monthly	58.7
Quarterly	8.3
Other (please specify).	10.9
There were no progress reports submitted by the project designer in Step 2	11.7

38. Which of the following best describes what happened in the 10% design review?

Serious problems were revealed and corrected	4.7%
Serious problems were revealed at this stage, but not corrected at this stage	1.9
Serious problems which later became apparent were not revealed at this stage	11.3
No serious problems were revealed at this stage, nor did they appear later	82.2

39. Which of the following best describes what happened in the 50% design review?

Serious problems were revealed and corrected	6.5%
Serious problems were revealed at this stage, but were not corrected at this stage	1.4
Serious problems which later became apparent were not revealed at this stage	12.6
No serious problems were revealed at this stage, nor did they appear later	79.5

40. Were any consultants employed in Step 2 to do value engineering?

Yes, but they did not improve design or reduce construction costs significantly (i.e., at least 10%)	3.4%
Yes, and they did improve design or reduce construction costs significantly	2.1
No, none employed for this purpose	94.1

41. During Step 2, what tasks were performed by consultants under contract to the grantee (other than the original project designers)? (Please check all that apply.)

No consultants were used in Step 2 except the original designer's staff	57.5%
Value engineering	5.5
Grant administration to assist in meeting EPA and other agency requirements	18.5
Scheduling or cost control	9.8
Geotechnical services	26.4
Special construction services including management plans and constructability	7.1
Surveying services	29.1

42. Did the project designer submit a detailed master schedule for Step 2 work?

Yes	45.7%
No	54.3

43. Which of the following sis the master schedule for Step 2 include? (Please check all that apply.)

The project designer did not maintain a schedule for Step 2	22.8%
Detailed estimated cost for each activity	27.2
Detailed presentation of timetables	36.6
Application dates for permits necessary for construction	29.9
Outside agency approvals	29.9
None of the above	17.3

44. How often was Step 2 work formally reviewed to insure that it followed the schedule?

Every week	6.7%
Every other week	4.9
Monthly	38.8
Quarterly	6.7
The Step schedule was not formally reviewed	42.4

45. How was compliance with the schedule enforced? (Please check all that apply.)

The Step 2 work never fell behind schedule	40.2%
Notification to the project designer of his failure to comply with the schedule was needed to insure compliance	6.3
A threat to withhold payment was made and was sufficient to insure compliance	6.3
Payment was withheld to force compliance.	3.1
The grantee had to change or terminate the project designer	3.5
The grantee had to change or terminate the project designer	1.6
There was no systematic enforcement of the Step 2 schedule	42.9

46. How close to the schedule time was Step 2 completed?

Step 2 was completed on time	64.8%
Completed less than 30 days late	8.2
Completed 30 to 89 days late	10.0
Completed 90 to 179 days late	4.1
Completed at least 6 months but less than 1 year late	5.5
Completed at least 1 year late	5.9

47. Who paid the additional design cost associated with any delay in completing Step 2?

Step 2 was completed on time	64.8%
The project designer bore the entire additional cost	17.8
The grantee bore the entire additional cost	7.5
Both shared the costs	3.3
EPA or other funding agency reimbursed the grantee for the additional costs	5.6

48. Were there any disputes arising from Step 2 that led to litigation or arbitration?

Yes, there was litigation or arbitration	1.7%
There was a Step 2 dispute, but it was settled prior to litigation or arbitration	6.4
There was no dispute that threatened arbitration or litigation	91.5

49. How much did the award or final settlement cost the grantee or other funding agency?

There was no litigation or settlement entered arising from Step 2 work	93.2%
Less than 2% of the cost of Step 2 work	3.2
2 to 4.9% of the cost of Step 2	.5
5 to 9.9% of Step 2	.5
10% or more of the cost of Step 2	1.8

Questions About Step 3

In the following questions, the term "Construction Manager" represents the private, professional firm with primary responsibilities for grant and construction contract administration.

50. What role has the Step 2 designer's organization had in Step 3? (Please check all that apply.)

The Step 2 designer was not involved in Step 3	3.1%
The Step 2 designer is acting as the Construction Manager	52.4
The Step 2 designer provided technical review (i.e., review of contractor's submittals, shop drawings, etc.) in Step 3	73.6
The Step 2 designer provided construction engineering (e.g., resident engineer, field inspection, quality assurance)	71.7
The Step 2 designer provided contract administration (e.g., change orders, time extensions, compliance with specifications, resolution of claims, schedule updating, progress payment computation)	75.6

51. Assuming that persons outside the grantee organization were employed, estimate how much the firm or person supervising or managing the Step 3 work will be paid as a percentage of the total construction cost.

Less than 1% of the total construction cost	15.2%
1 to 1.9%	6.8
2 to 3.9%	16.9
4 to 5.9%	14.8
6 to 8.9%	19.0
9% or more	13.5
The grantee supervised or managed construction with no outside help.	13.5

52. What are the grantee's estimated costs for force account services used for managing construction in Step 3 (including scheduling, cost accounting, and grant administration) as a percentage of the cost of Step 3?

Less than 1% of the cost of Step 3	66.1%
1 to 1.9%	15.0
2 to 3.9%	10.6
4 to 5.9%	4.8
6 to 8.9%	3.1
9% or more	.4

53. How long after the Step 3 approval to award was the Notice to Proceed given?

Less than 3 months after the Step 3 approval to award.	75.0%
At least 3 but less than 6 months later	15.0
At least 6 months but less than a year later	5.0
At least a year but less than 18 months later.	3.3
At least 18 months later	1.2

54. Who prepared the bid documents for Step 3? (Please check all that apply.)

Grantee	14.6%
Designer	94.5
Another consultant	1.6

55. Who reviewed the bid documents? (Check all that apply.)

EPA	77.6%
Grantee	85.8
State agency	83.1
Another consultant, other than the Construction Manager or designer	2.0
Construction Manager	28.3
There was no review of the bid documents	.8

56. Was any special scrutiny given to conspicuously low bidders in Step 3?

Yes	34.5%
No	65.5

57. Was there a bid protest in Step 3?

Yes	14.9%
No	84.6

58. What did the Step 3 bid protest in Step 3 involve? (Please check all that apply.)

There was no bid protest in Step 3	70.5%
Restrictive specifications	3.9
Irregularities in bid forms submitted	8.3
Minority business enterprise (MBE) requirements.	.8

59. Was the Step 3 contract awarded to the bidder with the lowest original price?

Yes	92.2%
No (i.e., the lowest bidder was judged nonresponsive or not responsible).	7.4

60. How many bids were received for Step 3?

1 bid	2.5%
2 bids	3.8
3 or 4 bids	23.7
5 or more bids	69.5

61. How did the engineer's estimated construction cost compare to the accepted bid?

The estimate was less than 85% of the accepted bid	12.8%
The estimate was 85 - 89,9% of the accepted bid	12.8
The estimate was 90 - 99.9% of the accepted bid	29.8
The estimate was 100 - 109.9% of the accepted bid	22.1
The estimate was 110 - 114.9% of the accepted bid	10.2
The estimate was a t least 11% of the accepted bid	11.9

62. Which of the following did the "master schedule" prepared by the construction contractor (i.e., times and sequences for the principal construction activities) include? (Please check all that apply.)

The "critical path," even if not represented by a CPM network.	21.3%
Project total cost for completion of each major activity.	44.1
Timetables for EPA and other agency reviews and approvals	20.1
Estimated schedules and durations for the major activities	74.0

63. Who reviewed the contractor's schedule when first submitted to ensure that it was realistic and workable? (Please check all that apply.)

There was no review of the contractor's schedule for this purpose.	4.7%
Construction Manager	50.8
Local government officials or grantee employee	44.5
Resident engineer	51.6
The Step 3 contractor did not submit a schedule	3.1

64. What do the grantee specifications require the contractor to provide on the schedule for Step 3? (Please check all that apply.)

Major work activities	69.7%
Durations of major activities	63.4
Estimated costs for each activity	47.2
Critical completion dates	39.4
Bar charts	41.7
"Critical Path" networks	12.2
Line-of-balance schedule charts	4.3

65. How willing is the construction contractor to submit schedules?

Very willing	32.6%
Moderately willing (i.e., needed to be requested)	54.7
Unwilling, but did submit a schedule	10.2
Completely unwilling and did not submit a schedule	1.7

66. How frequently are schedule reviews during Step 3?

Weekly or more often	14.2%
Every other week	5.4
Monthly	56.8
Quarterly	7.1
There are no formal schedule reviews for Step 3	15.9

67. Is the schedule updated with each review to reflect the current progress of Step 3 work?

Yes	62.1%
No	37.1

68. How frequently does the grantee verify construction progress?

Weekly or more often	29.8%
Every other week	3.3
Monthly	58.3
Quarterly	4.1
At completion of the project	3.7

69. Who verifies the schedule and work in progress during Step 3? (Please check all that apply.)

Grantee employees or other government officials	63.0%
Another consultant independent of contractor	17.3
Construction Manager independent of contractor	55.5

70. Who reviews the schedule and work in progress during Step 3? (Please check all that apply.)

Grantee employees or other government officials	68.9%
Another consultant independent of contractor	16.5
Construction Manager independent of contract	53.5

71. What happens when construction work falls behind schedule during Step 3?

There are no occasions when construction falls behind schedule	20.7%
Notifying the construction contractor that the work is behind schedule is sufficient to insure compliance	37.9
A threat to withhold payment or resort to liquidated damages provision is needed to insure compliance with schedule	20.7
Payment is withheld to insure compliance	10.3
The schedule for Step 3 is not enforced	3.9
Existing EPA regulations for retention do not permit adequate grantee schedule enforcement	5.6

72. How many change orders are estimated for Step 3?

Less than 25	86.7%
25 to 49	6.7
50 to 99	5.0
100 to 199	1.2
200 to 499	.4
500 or more	---

73. What is the total estimated value of all change orders as a percentage of the cost of Step 3?

Less than 2% of the Step 3 cost	44.3%
2 to 4.9%	30.8
5 to 9.9%	13.9
10 to 14.9%	3.4
15% or more	4.2
Change orders resulted in a net reduction of Step 3 cost.	3.0

74. What are the principal causes of change orders during Step 3? (Please check all that apply.)

Clarification of contract documents	24.4%
Changed condition	74.0
Substantial design changes or additional work	41.7
Substitutions	29.1
Changes required as a result of shop drawing review	20.1

75. Please estimate the proportion of all change orders during Step 3 that are initiated by the project designer, by the construction contractor and by the construction manager. (Check one box for each column.)

	Project Designer	Construction Contractor	Construction Manager
Initiated at least 50% of the change orders	42.2%	33.5%	44.1%
Initiated 25-49.9% of the change orders	15.5	18.2	17.1
Initiated 10-24.9% of change orders	9.7	16.7	8.2
Initiated less than 10% of the change orders	19.4	16.7	12.4
Did not initiate any change orders	12.6	14.8	17.6

76. How many outside firms, if any, were seriously considered for Construction Management in Step 3?

None; the grantee provided the necessary services	28.6%
None; the project designer acted as Construction Manager.	62.2
One firm was considered	4.1
2 or 3 firms were considered	3.7
4 or more firms were considered	1.2

77. In hiring a Construction Manager for Step 3 construction, what particular skills possessed by the firm were considered most valuable to the grantee? (Please check all that apply.)

No Construction Manager was hired for Step 3	48.8%
Scheduling experiences	15.4
Project design expertise	36.2
Geotechnical services	4.7
Grant administration skills	28.3
Ability to resolve or prevent disputes between grantee and contractors	23.2
Inspection and technical review of contractor submittals.	30.7

78. Who was most active in managing and monitoring the activities for Step 3?

The grantee	24.1%
Construction Manager	32.8
The project designer from Step 2	42.7
Some other consultant (neither the project designer no construction manager	.4

79. Which of the following issues did the grantee and EPA discuss in the pre-construction conference? (Please check all that apply.)

There was no pre-construction conference between EPA and the grantee.	39.0%
Cost control and scheduling techniques	31.1
Change order policies	41.3
Eligibility or allowability of costs	34.6
Grantee's inspection responsibility	38.6
Management types or techniques	12.2
The grantee's responsibility fro grant management	39.8

80. Compared to the contractor's original schedule, what is the actual or estimated construction time?

Construction is expected to be, or has been, completed on schedule (or earlier than schedule)	25.6%
Construction is expected to be, or has been, completed within 90 days after the original completion date	25.2
Construction is expected to take, or has taken, 90 to 179 days longer than scheduled	19.3
180 to 269 days longer than scheduled	11.3
270 to 364 days longer than scheduled	5.5
At least a year, but less than 2 years, longer than scheduled	6.7
At least 2 years longer than scheduled	6.3

81. How did the actual construction costs compare with the original construction contractor's bid?

Actual construction costs were lower than the original bid	20.8%
Actual construction costs were less than 3% higher than the original bid	41.1
3 to 4.9% higher	14.4
5 to 9.9% higher	16.1
10 to 14.9% higher	3.4
15 to 24.9% higher	2.1
25% or higher	2.1

82. Thinking first only of those Step 3 cost increases that were ruled grant-ineligible, please indicate what percentage were paid by the A&E firm, by the construction manager, grantee, and by the construction contractor. (Please check one box for each column.)

Of those Step 3 cost increases ruled grant-ineligible:	A&E Firm	Construction Manager	Grantee	Construction Contractor
Paid more than 50% of them	1.1%	.7%	78.2%	1.8%
Paid 25 - 49.9%	1.7	1.3	2.8	1.8
Paid less than 25%	10.9	4.0	3.3	13.9
Paid none of them	86.3	94.0	15.6	82.4

83. And now thinkng only of those Step 3 increases that were ruled grant-eligible, please indicate what percentage were paid by the person or organization indicated. Again, please check one box for each column.

Of those Step 3 cost-increases ruled grant-eligible:	Construction Manager	Grantee	EPA or Other Funding Agency
Paid more than 50% of them	.7%	22.9%	84.5%
Paid 25-49.9%	---	31.8	4.2
Paid less than 25%	93.4	11.9	8.5

84. Thinking of all claims between the construction contractor and the grantee resulting from construction disputes, who received (or will receive) the bulk of the award?

There were no claims as a result of construction	75.2%
The contractor received the bulk of the award	16.2
The grantee received the bulk of the award	7.7

85. Were performance bonds used to complete construction in Step 3?

Yes	33.2%
No	66.4

86. Who reviewed the project during Steps 2 and 3 to insure easy operation of the finished facility? (Please check all that apply.)

Treatment process expert	12.2%
Architect or project designer	74.0
Grantee or local government officials	70.1
There was no review for this purpose	5.9

87. Did the State or any other governmental agency under the Intergovernmental Personnel Act (IPA) lend any personnel to assist in any step of the project? (Please check all that apply.)

No, no personnel were lent to us	88.2%
Yes, during Step 1	2.8
Yes, during Step 2	4.3
Yes, during Step 3	5.5

88. Who contributed to funds (not counting loans) for the project? (Please give percentages which each contributed.)

EPA	* %
State	*
Grantee	*
Industrial Contribution	*
Other	*

Total = 100%

89. How much time was required (or is now forecasted) for the entire project to go from the start of Step 1 until the end of Step 3?

__*__ months

90. How long was the grantee on the priority list before receiving the Step 1 grant?

Less than 6 months	26.7%
At least 6 months, less than a year	18.8
At least 1 year, less than 3 years	37.6
At least 3 years	16.8

91. Is the project now in full operation?

Yes	82.0%
No	17.6

*No statistical analysis has yet been conducted.

92. Thinking of all phases of the project, were there any change orders that appeared to be approved for grant eligibility by EPA or by the delegated state, but later disapproved? (If so, please indicate the cost.)